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FARMERS' BULLETINS
Nos. 1451-1475

WITH CONTENTS

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1451

MAKING AND USING COTTAGE CHEESE *in* THE HOME

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COTTAGE CHEESE is a highly nutritious and palatable product and is a means of utilizing skim milk to excellent advantage. It can be manufactured on the farm and in the home with but little labor and expense.

Directions given in this bulletin for manufacturing cottage cheese are suitable for making it for use in the home or for marketing on a small scale. Recipes are also given for the use of cheese on the table in both the cooked and uncooked forms as well as its use in the preparation of various appetizing dishes.

This bulletin supersedes Farmers' Bulletin 850, How to Make Cottage Cheese on the Farm, and Office of the Secretary Circular 109, Cottage Cheese Dishes.

Washington, D. C. **Issued May, 1925**

MAKING AND USING COTTAGE CHEESE IN THE HOME

By Kenneth J. Matheson and Jessie M. Hoover, *Bureau of Dairying*

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A DESIRABLE FOOD EASILY PREPARED

COTTAGE CHEESE, a highly palatable and nutritious product, is one of the few varieties of cheese which can be manufactured on a small scale. From an economic standpoint, skim milk should be utilized as a human food rather than as an animal food. In cottage cheese is found a convenient and economical means of using skim milk as human food.

The haphazard methods used in the making of this product, together with the lack of simple and easily available directions, probably are responsible for the small quantities made and consumed in the home. Uncertainty of results and defects in the finished product also have been causes for discouragement to the beginner. It is hoped, however, that by following the directions given in this bulletin a better and more uniform product may be obtained.

The making of cottage cheese in small quantities for home use is a very simple process and ordinary household equipment will suffice. But if it is desired to market the product and to insure good, uniform quality it will be necessary to follow somewhat more elaborate methods. Details of manufacture sometimes must be modified according to conditions, and proficiency will be gained by experience.

QUALITY AND ITS REQUISITES

Cottage cheese is judged by its flavor and texture. A high-quality cheese should have a clean, mild, acid flavor and a smooth texture, free from lumps, and uniform or homogeneous throughout. The undesirable flavors commonly found are described as unclean, tasteless, too acid, and sometimes even bitter. Flavor can be controlled by the use of clean, sweet skim milk and a good starter, but texture depends largely upon careful manipulation during the process of making. Good clean skim milk, clean utensils, and careful attention to details are essential to good quality in the product.

GOOD SKIM MILK NECESSARY

The first consideration in the production of good cottage cheese is the quality of the milk itself. Milk which is dirty or has undergone any abnormal fermentation is undesirable. The fresher the milk the more satisfactory it is for cheesemaking, as then it is possible to direct and control the souring. It is absolutely necessary to give the milk proper attention both at the time of its production and in its subsequent handling. The temperature at which it is kept from the time of production until it is made into cheese determines in large measure the quality of the cheese. For best results milk should be kept cool, at 50° F., if possible, until it is to be made into cheese.

EQUIPMENT FOR MAKING COTTAGE CHEESE

Little equipment is needed for making cottage cheese, and for the most part it may be found in any home. When the cheese is made in large quantities a small outlay for equipment is warranted as a matter of convenience and satisfaction. In most homes, however, satisfactory substitutes may be found for some of the utensils mentioned here.

Starter bottles.—Quart milk bottles and tumblers are needed for holding the starter. Quart fruit jars will serve the purpose very well.

Cans or pails.—A shotgun can which may vary in size and material is very convenient; usually it is straight sided, 8 inches in diameter, 20 inches high, and holds about 4 gallons of milk. If such a can is not available, an ordinary 10-quart milk pail will be satisfactory.

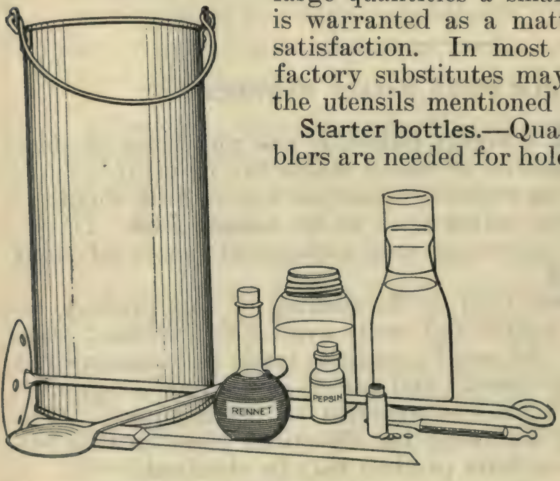

FIG. 1.—Equipment used in first stages of making cottage cheese

Milk agitator.—A stirrer of the kind shown in Figure 1 is desirable for getting a uniform distribution of the starter and rennet prior to setting and for stirring the curd, but for making small quantities of cheese a spoon is entirely satisfactory.

Floating dairy thermometer.—The use of a reliable and accurate thermometer is absolutely necessary to obtain uniformity in results from day to day. Because of the danger of breaking, it should be kept in a case when not in use.

Rennet tablets.—Either commercial liquid rennet or junket tablets are desirable when cottage cheese is to be made quickly. Rennet always should be kept cold and in a dark place.

Draining racks.—An ordinary fruit-draining rack is very useful for small quantities of cheese. A colander also will answer the purpose. When larger quantities are made a special wire-covered rack will be found very convenient. Such a rack (fig. 2) consists of a rectangular frame, 20 by 52 inches and 6 inches high, upon the bottom of which is tacked one-half inch mesh woven wire. The rack should be made of hardwood and dovetailed at the corners. If it is placed slightly inclined upon a table, the whey is directed to a common point and collected in a jar or pail by the use of strips nailed to the bottom of the frame. The materials required for making the rack are two boards ⅞ by 6 by 52 inches, two boards ⅞ by 6 by 26 inches, and woven wire 26 by 52 inches.

Another kind of rack is rectangular, 13 inches wide, 36 inches long, and 10 inches deep. The corner posts extend 1½ inches beyond the strips and top and bottom, with the top rounded, so that a ring may fit over them. The bottom slats fit loosely into notches and are removable for washing. The materials required are 4 corner posts 1½ by 1½ inches, 9 strips 1 by ⅜ by 36 inches, and 6 strips 1 by ⅜ by 12¼ inches, notched to receive bottom slats, all made of pine. A cloth is fastened upon each frame and the contents of one can poured into each cloth.

Draining cloths.—When the cheese is made without rennet, common cheesecloth is most satisfactory, but for cheese made with rennet, unbleached cotton sheeting is recommended. The quantity depends upon the size of the draining rack, enough being required to supply a single thickness, with an allowance for hems. All draining cloths should be hemmed.

Packages.—Round, paraffined, sanitary, single-service paper containers, or glass jars with paper caps, are desirable for marketing the cheese.

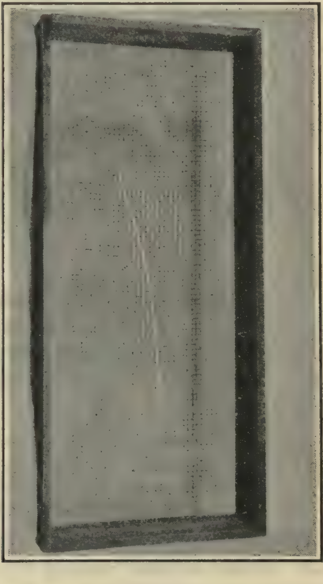

FIG. 2.—Wire-covered draining rack

MAKING SMALL QUANTITIES FOR HOME USE

One gallon of skim milk will make about 1½ pounds of cheese. If the milk is sweet it should be placed in a pan and allowed to remain in a clean, warm place at a temperature of about 75° F. until it clabbers. The clabbered milk should have a clean, sour, and pleasant flavor. Ordinarily this will take about 30 hours, but when it is desirable to hasten the process a small quantity of well-flavored sour milk may be mixed with the sweet milk.

As soon as the milk has thickened or firmly clabbered it should be cut into pieces 2 inches square, after which the curd should be stirred thoroughly with a spoon.

The next step is to heat the curd. Heating makes the whey separate readily, and aids in giving the cheese a firm texture. Place the pan of broken curd in a vessel of hot water so as to raise the temperature to 100° F. Cook at that temperature for about 30 minutes, during which time stir gently with a spoon for 1 minute at 5-minute intervals.

At the conclusion of the heating, pour the curd and whey into a small cheesecloth bag (a clean salt bag will do nicely) or lay it upon a cloth and fold over the cloth to form a bag; then hang it on a fruit-drainer rack or elsewhere to drain. Draining may be hastened by laying the bag between two pie plates or clean boards and placing a weight on top. Sometimes the curd is poured into a colander or a strainer over which a piece of cheesecloth has been laid. After 5 or 10 minutes, work the curd toward the center of the colander with a spoon. Raising and lowering the ends of the cloth helps to make the whey drain faster. To complete the draining tie the ends of the bag together and hang it up. Since there is some danger that the curd will become too dry, draining should stop when the whey ceases to flow in a steady stream.

The curd is then emptied from the bag and worked with a spoon or a butter paddle until it becomes fine in grain, smooth, and of the consistency of mashed potatoes. Sour or sweet cream may be added to increase the smoothness and palatability and improve the flavor. Then the cheese is salted according to taste, about 1 teaspoonful to 1 pound of curd.

Because of the ease with which the cheese can be made it is desirable to make it often so that it may be eaten fresh. If the cheese is not to be eaten promptly it should be stored in an earthenware or glass vessel rather than in one of tin or wood, and if kept in a cold place it will not spoil for several days.

THE USE OF STARTERS

The first step in the making of cottage cheese is to sour or ripen the milk. If care has been used in the production and handling of milk, a good grade of cheese may be made by allowing the milk to sour naturally. Some of the dangers and disadvantages of natural souring are:

1. Slow coagulation or curdling.
2. Gassy and undesirable fermentations, causing loss of curd in whey.
3. Bitter and other undesirable flavors.
4. Lack of uniformity in the cheese.

Uncertainty of results and lack of uniformity in the cheese, however, have caused many to resort to a more definite means of controlling fermentation or souring by the use of starters. Starters aid and hasten acid fermentation and tend to suppress and eliminate undesirable fermentation. A home-made starter is a quantity of sour milk in which desirable acid-forming bacteria have grown until the milk contains a large number of them. When mixed with fresh milk these particular bacteria are given a start in the fresh milk over any other bacteria which might gain access.

COMMERCIAL STARTERS

When cottage cheese is to be produced in large quantities it is advisable to use a commercial starter, obtainable from a reliable starter company or through a dairy-supply house. The small package of starter, which may be either liquid or dried, is added to a pint of pasteurized milk and the milk cooled, covered, and set away at 75° F. to sour. This is called a "mother starter." After curdling or coagulation, a teaspoonful of the mother starter is added to a quart of pasteurized skim milk, which, when coagulated, is used to ripen the milk for cheesemaking. In pasteurizing milk for starters, it is heated to 175° F. and held at that temperature for 30 minutes, after which it is cooled to 75° F. before the starter is added.

HOMEMADE STARTERS

Homemade starters are prepared as follows:

1. Clean thoroughly several pint fruit jars or wide-mouthed bottles, together with tops or tumblers for covering them and boil for five minutes (fig. 3). After boiling, keep the jars or bottles covered to prevent the entrance of bacteria.
2. Select several pint samples of fresh milk, put into the jars or bottles, cool to 75° F., cover and keep at that temperature until curdling occurs.
3. The curdling or coagulation should take place in about 30 hours. An ideal curd should be firm, smooth, marblelike, free from holes or gas bubbles, and showing little separation of the whey. To be a good starter the curd should have a clean, sharp, sour or acid flavor.
4. Select the sample that most closely meets these conditions and propagate it. This is done as follows:

a. Shortly before using, sterilize a quart jar or bottle and a teaspoon according to the method described in paragraph 1.

b. Fill the jar or bottle with fresh skim milk and pasteurize by heating to 175° F. and keeping at that temperature for 30 minutes.

c. Cool to 75° F. and add a teaspoonful of the curdled milk or starter selected as best, and set away to curdle.

d. When a starter with desirable qualities has been found, propagate it from day to day.

FIG. 3.—Bottles of starter.

PASTEURIZATION

While in small-scale operations the pasteurization of milk for cheese may not always be practicable, it permits a better control of the fermentations, increases the yield of cheese, and renders the product safe from disease-producing organisms. If milk is pasteurized just before being used for cheese-making it is absolutely necessary to use a vigorous starter for ripening. Otherwise, great difficulty is found in draining the curd, and as a result the cheese will probably be spoiled.

Skim milk is pasteurized for making cottage cheese by heating it in a pail, can, or vat to a temperature of 145° F. and holding it at that temperature for 30 minutes. The milk then is cooled quickly to 75° F., when it is ready for adding the starter.

MAKING CHEESE ON A LARGE SCALE

To make cottage cheese in considerable quantities and of good, uniform quality, it is desirable to follow a more exact method than that described for making small quantities for home use.

SETTING

For natural souring without starter, fresh skim milk is placed in a clean pail or a shotgun can, covered, warmed to 75° F., and allowed to stand at that temperature until curdled. The temperature can be controlled by keeping the pail or can of milk in a tub, sink, or other vessel filled with water at the same temperature.

When starter is used it is stirred into skim milk which has been warmed to 75° F. (fig. 4). The vessel of milk is then covered and set away at the same temperature to curdle. The quantity of starter used varies from 1 to 5 per cent; a pint for 3 to 4 gallons of milk usually gives good results. By the use of a large quantity of starter it is possible to ripen the milk and complete the making of the cheese in one day. Probably it is more convenient, however, to set the milk with starter at night, in which case the milk should be firmly clabbered by morning. For obtaining a desirable curd that is firm and not easily broken into fine particles during heating, 75° F. seems to be the best temperature. When the skim milk has coagulated into a firm, solid curd which gives a sharply defined break as the finger is inserted, with whey collecting at the break, the curd is ready for cutting.

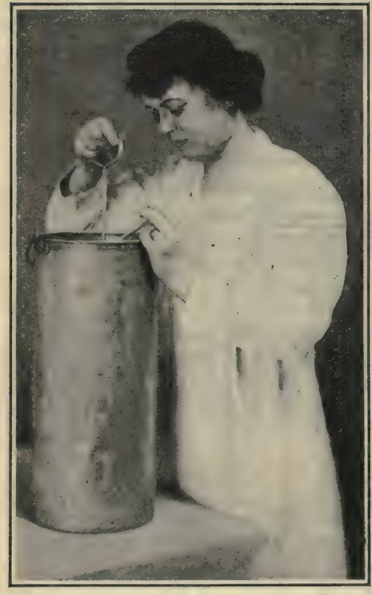

FIG. 4.—Stirring in starter and taking temperature

CUTTING, HEATING, AND STIRRING

The curd is cut crosswise into 2-inch squares, with a long-bladed knife. It is then heated quickly to 100° F. and maintained at that temperature for about 30 minutes. During the entire heating process the curd is stirred with a spoon or a cream agitator every four or five minutes. The object of these operations is to remove the whey from the curd and to bring the product into a concentrated form. The texture of the cheese is regulated in a large measure by the manner of cutting, heating, and stirring the curd. Prolonged and vigorous stirring is undesirable, since it causes a fine-grained curd which is slow in draining and has excessive curd losses in the whey. Heating at too high a temperature results in a tough, dry curd.

DRAINING

After heating, the mixture is poured upon cheesecloth, which is fastened over a pail or a specially constructed rack, in order to separate the curd from the whey. (See fig. 5.) The curd is allowed to drain undisturbed for 15 or 20 minutes, because if handled during that period it will tend to become mushy, a condition which renders the removal of the whey very difficult. Later, every few minutes, the sides of the cloth should be raised and lowered several times (as shown in fig 5), which hastens draining. Draining should continue until very little whey separates upon standing, at which time the curd is rather soft and smooth. It is then ready for salting.

SALTING

The curd is then placed in a pan or pail and salt is added and mixed uniformly into the curd with a butter ladle or a spoon. The usual rate of salting is 2 heaping tablespoonfuls to 3⅓ gallons of milk, or about 2½ ounces to 10 pounds of curd, although there is some difference of opinion as to the quantity of salt needed. In case a scale is lacking it is possible to approximate the salt when it is known that a level tablespoonful of salt equals two-thirds of an ounce. Salt is added to the cheese to increase its palatability and to a certain extent to preserve it.

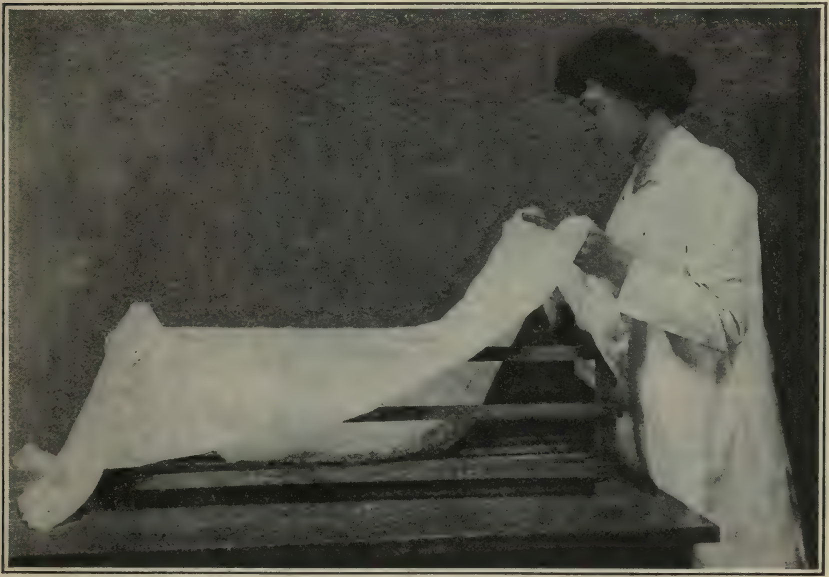

FIG. 5.—Raising and lowering draining cloth to hasten draining

MAKING THE CHEESE WITH RENNET

Several advantages are found in making cottage cheese with rennet, as follows:

1. A finer-textured and more uniform cheese results.
2. Making requires less time and attention.
3. Losses of curd in the whey are reduced.

Rennet is a substance which causes milk to coagulate; it may be obtained either as commercial liquid rennet or as junket tablets. The former may be purchased from dairy-supply houses, while the latter may be obtained from grocers and druggists.

If commercial liquid rennet is used for making cottage cheese, about 3 drops should be added to each 10 pints or pounds of milk, or 10 drops to 30 pounds of milk. The rennet, after being measured, is diluted about 40 times with cold water (a half cupful is satisfactory) before it is added to the milk. For measuring rennet a medicine dropper may be used with good results.

If liquid rennet can not be obtained, junket tablets may be used, one tablet having about the same strength as 1 cubic centimeter or 25 drops of the liquid. One tablet may be dissolved in 10 tablespoonsful of cold water, then 1 tablespoonful of the mixture is sufficient for 10 pounds or pints of skim milk and 3 tablespoonfuls for 30 pounds of milk. Junket tablets are not always of the same strength, so it may be necessary to experiment somewhat before the right quantity to add is obtained.

The milk is handled in identically the same manner as in the method already described with the exception that rennet is added to it just after the starter is put in and the mixture stirred vigorously. If no starter is used it is desirable to let the milk stand at 80° F. for five or six hours before adding the rennet. After the addition of rennet, the milk is allowed to stand until curdled.

When clear whey collects upon the surface of the curd in the can it is an indication that the curd is ready to be drained. At first it may not be possible to get the best results by this method, but after a few trials it should be possible to produce a fine, firm curd in from 12 to 15 hours.

If rennet or junket tablets are used, the curd should not be heated, as this will make the cheese too hard and tough. The draining may be done without preliminary cutting or stirring.

The curd is now poured upon the draining rack covered with cotton sheeting. Because of the fineness of the curd a draining cloth with a smaller mesh than cheesecloth is desirable. After a short preliminary drainage of about 20 minutes the ends of the cloth are unfastened and the diagonally opposite corners drawn together and tied. Moderate weights, about 25 pounds, are then placed upon the bag of curd to hasten the draining. (See fig. 6.) A pail filled with stones or water will serve for this purpose. There is danger that the cheese curd may be pressed too dry when rennet is used, so it is advisable to watch the curd closely during this period. The pressing should be continued until the curd has reached about the same consistency as described under the preceding method.

After draining, salt is added in the same way as for ordinary cottage cheese.

ADDING CREAM AND PEPPERS

A small quantity of sweet or sour cream added after salting, especially if the curd is a little dry, will improve greatly the quality and palatability of cottage cheese made by either process. Usually cream is added at the rate of half a pint to 10 pounds of curd.

Finely ground pimento peppers also add much to the appearance, taste, and attractiveness of the product, especially to the finer textured, rennet-made cheese. Peppers are added at the rate of 1 pound of peppers to 20 pounds of curd.

If the product is to be marketed the additional expense of cream or peppers probably is warranted.

YIELD OF CHEESE

The yield of cottage cheese depends upon the quality of the milk and the method of manufacture. Yields of 12 and 20 pounds of cheese per 100 pounds of skim milk represent the limits, whereas a normal yield of from 16 to 18 pounds produces best results.

MARKETING THE PRODUCT

Although often marketed in bulk and sold by the pound, cottage cheese may be marketed best in single-service containers holding from 10 to 12 ounces. This makes a neat and convenient package which commonly retails for about 10 cents. These cartons are made of wood pulp treated with paraffin. For interstate shipping it is necessary to put the net weight of these cheeses on the package, and it is desirable, for advertising purposes, to place on it the name and address of the maker. While the product may be molded into balls or prints and wrapped in paraffined paper, the carton is strongly recommended as a marketing receptacle for so perishable a product as cottage cheese. The carton makes a nearly air-tight package which retards deterioration of the cheese.

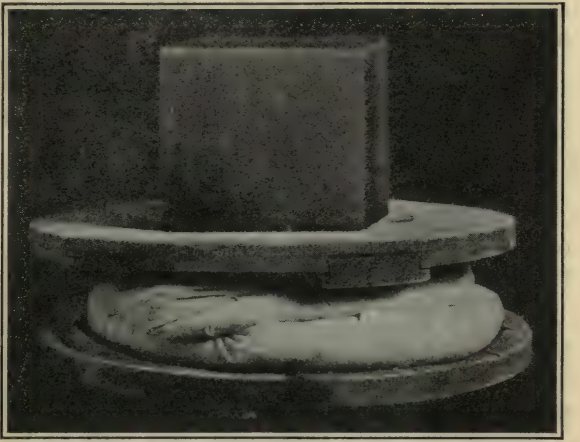

Fig. 6.—Boards and weight for pressing cheese.

Recently a 12-ounce jar, provided with a paper cap, and fitting into a regular pint milk-bottle crate, has been successfully used in the marketing of cottage cheese. Such a container may be readily washed, sterilized, and used again. With such a receptacle there is little chance of imparting an objectionable taint to the cheese.

It is advisable to keep cottage cheese at a low temperature until consumed. Holding the product at room temperature for only 36 hours may cause it to become slightly "off flavor," whereas in a longer period the deterioration may be so marked as to render it unsuitable for consumption. Cheese from which the whey separates spoils quickly and is very undesirable. It is better to have the cheese a little too dry than too moist, for the former defect may be corrected easily by the addition of a little cream or milk by the consumer.

SUMMARY OF ORDINARY PROCESS OF MAKING COTTAGE CHEESE

The process of making cottage cheese without rennet, on the basis of 30 pounds or about 3½ gallons of milk, which will yield about 5¼ pounds of cheese, may be summarized as follows:

Obtain clean, fresh skim milk.

If starter is not used, warm the milk to 75° F. and hold it at about that temperature until curdled.

If starter is used, add from 1 to 5 per cent, or about 1 pint of starter to 30 pounds of milk, stir, and set away at 75° F. to curdle.

If it is desired to pasteurize, heat milk to 145° F., hold at that temperature for 30 minutes, and cool to 75° F. If pasteurization is practiced, a starter must be used and should be added after pasteurization, as described.

Time for curdling when starter is used, from 12 to 15 hours (usually overnight).

When starter is not used the time for curdling will be about 30 hours.

Cut and stir, and then heat to 100° F. and hold for 30 minutes. Stir gently at intervals.

Pour upon cheesecloth and drain for 20 or 30 minutes.

Place in pail or pan and salt at the rate of 2½ ounces to 10 pounds of curd, or about 2 level tablespoonfuls for the cheese from 30 pounds of milk.

If desired, add sweet or sour cream at the rate of one-half pint to 10 pounds of curd, or about one-quarter pint of cream to the product from 30 pounds of milk.

SUMMARY OF RENNET PROCESS OF MAKING COTTAGE CHEESE

The following is an outline of the process with rennet on the basis of 30 pounds or 3½ gallons of milk, which will yield about 5¼ pounds of cheese:

Obtain clean, fresh skim milk.

When a starter is not used, after adding rennet, warm the milk to 75° F. and hold it at about that temperature until curdled.

If starter is to be used, add from 1 to 5 per cent, or about 1 pint of starter to 30 pounds of milk, and set away at 75° F. to curdle.

If it is desired to pasteurize, heat milk to 145° F., hold at that temperature for 30 minutes, and cool to 75° F. If pasteurization is practiced, a starter must be used and should be added as described.

Add rennet or junket tablets just before setting the milk away to curdle at 75° F., carefully stirring to insure a thorough distribution.

Add rennet at the rate of one-third cubic centimeter, or about 10 drops, diluted 40 times in cold water (half a cup of cold water is satisfactory) for each 30 pounds or 3½ gallons of milk.

Or, dissolve one junket tablet in a pint of cold water and use one-third of the mixture.

The time needed for curdling, when starter is used, is 12 to 15 hours (usually overnight); when starter is not used the time will be about 30 hours.

Pour upon cotton sheeting and drain for 20 to 30 minutes.

Tie the ends of the cloth together and press with weights) 20 to 25 pounds) until the curd has attained the desired consistency.

Salt at the rate of 2½ ounces to 10 pounds of curd. If desired, add sweet or sour cream at the rate of one-half pint of cream to each 10 pounds of curd, or one-quarter pint of cream to the product from 30 pounds of milk.

USES OF COTTAGE CHEESE

Cottage cheese is high in nutritive value, containing all the constituents of milk except the cream. Like milk, it is a source of protein, which is used to build and repair body tissue.

Physicians often find a milk diet useful in treating the sick. In many of these cases it may be possible to substitute cottage cheese, with added cream or butter if desired, for part or all of the milk. Thus a pleasing variety is introduced, and the bulk is lessened.

There is an abundance of skim milk, the material from which cottage cheese is made. It is used extensively for feeding animals; everyone knows that it is good for calves, pigs, and chickens, and that they make their best growth when it is abundant in the ration. The fact that skim milk can supply a rich and nourishing food for the family table has not been so fully recognized.

Cottage cheese is in fact a food that, served either alone or in combination, may form an important part of the diet. In salads, desserts, or cooked dishes, cottage cheese may be used to advantage. As a basis for the main dish of a meal it may often reduce expense, and appeal to the appetite as well as supply nourishment. Few people realize the diversity of its uses.

DELICIOUS COTTAGE-CHEESE DISHES

Those who are responsible for the planning and preparation of meals have found that cottage cheese combined with other foods can be made into many appetizing and attractive cooked and cold dishes. The cheese made by the rennet process, which is smooth and mildly acid, is more satisfactory for use in cooked dishes, while the cheese soured by the natural method is more suitable for cold dishes. To point out some of the many ways in which cottage cheese may be served, the suggestions below are given.

PLAIN COTTAGE CHEESE

Most people like plain uncooked cottage cheese. It is especially pleasing in summer, and when blended with rich cream and a little salt it is enjoyed by many. It is often eaten with sugar and cream. When cream is lacking, whole milk is used to moisten the cheese and sugar. Not only sweet cream, but sour cream or melted butter added to cottage cheese improves its flavor and increases the food value.

Cottage cheese, being mild in flavor, combines nicely with other things that give variety of flavor. Berries, peaches, or other fresh fruits may be used in this way; also canned fruits, raisins, cut dates, or other dried fruits, brown sugar, honey, jam or marmalade, or chopped nuts.

Broken nut meats, chopped pimentos, finely cut green peppers, diced cucumbers, or other crisp vegetables may also be mixed with the cheese. Horse-radish, onion juice, and parsley make a good combination.

Dry cheese should be seasoned well, packed into a buttered earthen or enamel dish, chilled, turned out on a platter, and served in slices. Ground sage makes a good seasoning.

Mix with the cheese a small quantity of finely ground left-over ham or corned beef and season the whole with mustard. Serve in slices or turn out the molded cheese on a border of lettuce leaves.

SALADS

Cottage cheese lends itself especially well to salads. If enough is used the salad may serve as the main dish of the meal. French, mayonnaise, or boiled dressings go well with cheese salad. The cheese may be formed into balls or slices; it may be molded in tiny cups or passed through a pastry tube. Foods that combine well with cottage cheese in salads are crisp, fresh vegetables; cooked or canned vegetables; fresh, dried, canned, or preserved fruits; nuts; olives; rice; potatoes. With the last two some highly flavored and bright garnish, like beets, pimentos, or green peppers, should be used; and celery, cucumbers, green peppers, crisp lettuce, or cabbage may be added to give succulence. Ground raw carrots and onions combine nicely with cottage cheese.

SANDWICH FILLINGS

Cottage cheese may be used as a sandwich filling. All kinds of bread lend themselves well to cottage-cheese sandwiches. The cheese may be combined with nuts, grated hard cheese, pimentos, horse-radish, chopped or sliced olives, whole or chopped nuts, sliced celery, chives, Spanish onions, raisins, dates, prunes softened by soaking, freshly crushed mint leaves, honey, jelly, or marmalade. These additions may be blended with the cheese or may be spread in a layer over it.

COTTAGE-CHEESE ROLL (UNCOOKED)

Seasoned.—Various loaves or rolls can be made by combining cottage cheese with cold cooked rice or with fresh bread crumbs, and seasoning with horse-radish, olives, chopped onions or onion juice, parsley, chopped celery, sage, pimentos, green peppers, grated hard cheese, or other desired seasoning. The flavor of onion, parsley, celery, or green pepper will blend more thoroughly with that of the cheese if these vegetables are cut finely and cooked for a few minutes in a little butter before being added to the roll. Chopped nuts, finely cut celery, or cubed cucumbers are pleasing additions. Left-overs of boiled ham, fried bacon, cold meats, salmon, tuna fish, or other fish may be used to add variety.

If desired the loaf may be rolled, just before serving, in sifted bread crumbs that have been slightly browned in the oven. These rolls are specially attractive if served on a bed of lettuce leaves, shredded lettuce, or grape leaves, and garnished with fresh or cooked vegetables that have been tossed in French dressing. Salad dressing is frequently served with these rolls.

Sweet.—Sweetened cheese rolls may be made for a hearty dessert. These may contain fresh, dried, or candied fruits and nuts, or they may be served with canned or preserved fruits as a garnish. Preserved ginger is particularly delicious served with such a cheese roll, as is also candied orange or grapefruit rind. The roll may be sprinkled with almond or macaroon dust, or with dry crumbs from stale cake.

COTTAGE CHEESE AND NUT LOAF

2 cups cottage cheese.
1 cup chopped nuts.
1 cup cold leftover cereal, any kind.
1 cup dry bread crumbs.
2 tablespoons chopped onion, or ½ teaspoon onion juice.
1 tablespoon fat.
Salt, pepper.
⅓ teaspoon or more of soda to neutralize acid.
Sage, poultry seasoning, or mixed herbs.
Worcestershire sauce, or kitchen bouquet, if desired.

Mix all ingredients together thoroughly, form into a loaf, and bake in a buttered pan in a hot oven for 20 to 25 minutes, or till top and sides are well browned. Turn out on a hot platter. Serve with a brown or tomato sauce if desired. This loaf is particularly good made with peanuts. Substitute for the cup of chopped nuts in the rule above, 2 tablespoons of peanut butter and ½ cup of coarsely chopped nuts, and season with ½ teaspoon of ground sage or with 1 teaspoon of mixed poultry seasoning. Where walnuts are used, pimentos make a good garnish.

COTTAGE-CHEESE PATTIES

1 cup cottage cheese.
1 cup dry bread crumbs; or ½ cup cold cooked rice, and ½ cup bread crumbs.
¼ cup peanut butter, or 2 tablespoons savory fat.
¼ cup coarsely chopped peanut meats.
½ teaspoon powdered sage.
½ teaspoon powdered thyme.
1 tablespoon milk.
1 teaspoon salt.
¼ teaspoon pepper.
⅓ teaspoon soda.
1 to 2 tablespoons finely chopped onion.

The bread crumbs, if desired, may be made from left-over quick breads.

Cook the onion in the fat until tender but not brown. Dissolve the soda in the milk and work into the cheese. Mix all other dry ingredients thoroughly with the bread crumbs. Blend peanut butter and onion with the cheese, and mix the bread crumbs with them. Form into flat cakes, dust with bread crumbs, cracker crumbs, or corn meal, and fry a delicate brown in a little fat in a hot frying pan.

Other seasonings may be used in place of those described above.

The quantity of liquid will vary in every case. The mixture should be very stiff, since the cheese tends to soften during the cooking.

To utilize left-over cereals, use 1 cupful of cooked rice, oatmeal, or corn-meal mush with ¾ cupful of bread crumbs.

Dry corn meal or finely ground oatmeal may be used for stiffening the above mixture, but in such case it is better to form into a loaf and bake it in the oven about 25 minutes.

COTTAGE-CHEESE BALLS

½ cup thick white sauce, made from ½ cup milk, 2 tablespoons flour, 1 tablespoon fat, salt, and pepper.
2 cups cottage cheese.
2 cups mashed potatoes.
1 egg, beaten.
Bread crumbs.

Make white sauce. Gradually beat cottage cheese into it. Add mashed potatoes, season, make into soft balls, roll in bread crumbs, then in beaten eggs, then in bread crumbs again. Fry in kettle of deep fat until a golden brown. These cheese balls are delicious served with tomato sauce.

COTTAGE-CHEESE CAKE

1½ cups cottage cheese.
1 tablespoon butter.
½ teaspoon salt.
¼ teaspoon vanilla.
⅔ cup milk.
1 tablespoon cornstarch.
⅔ cup sugar.
2 eggs.

Blend the cheese, butter, salt, and vanilla until smooth. Mix the milk and cornstarch and bring to a boil, stirring to prevent lumping or sticking. Add the sugar to the cooked milk and cornstarch, and heat. Pour the hot milk mixture over the slightly beaten eggs, stirring thoroughly, and heat to a custard consistency. Add the cottage cheese mixture to the custard, and pour into a deep baking dish which has previously been lined with shortcake dough. Bake until crust is done and slightly browned.

CRUST FOR COTTAGE-CHEESE CAKE

2⅔ cups flour.
6 tablespoons fat (lard).
4 teaspoons baking powder.
1 teaspoon salt.
⅔ cup milk.
2 tablespoons sugar.

Sift the flour, baking powder, salt, and sugar together. Work lard into flour, and add milk, forming into dough as for biscuits. Roll out crust about ¼ inch thick, and line the inside of baking dish.

STUFFED DATES, FIGS, OR PRUNES

Season cottage cheese with salt and thick cream, and with chopped nuts if desired. Remove stones from dates or soaked prunes, and open figs, for stuffing. Fill cavities with seasoned cottage cheese and whole nut meats or candied fruits. This makes an excellent confection or dessert.

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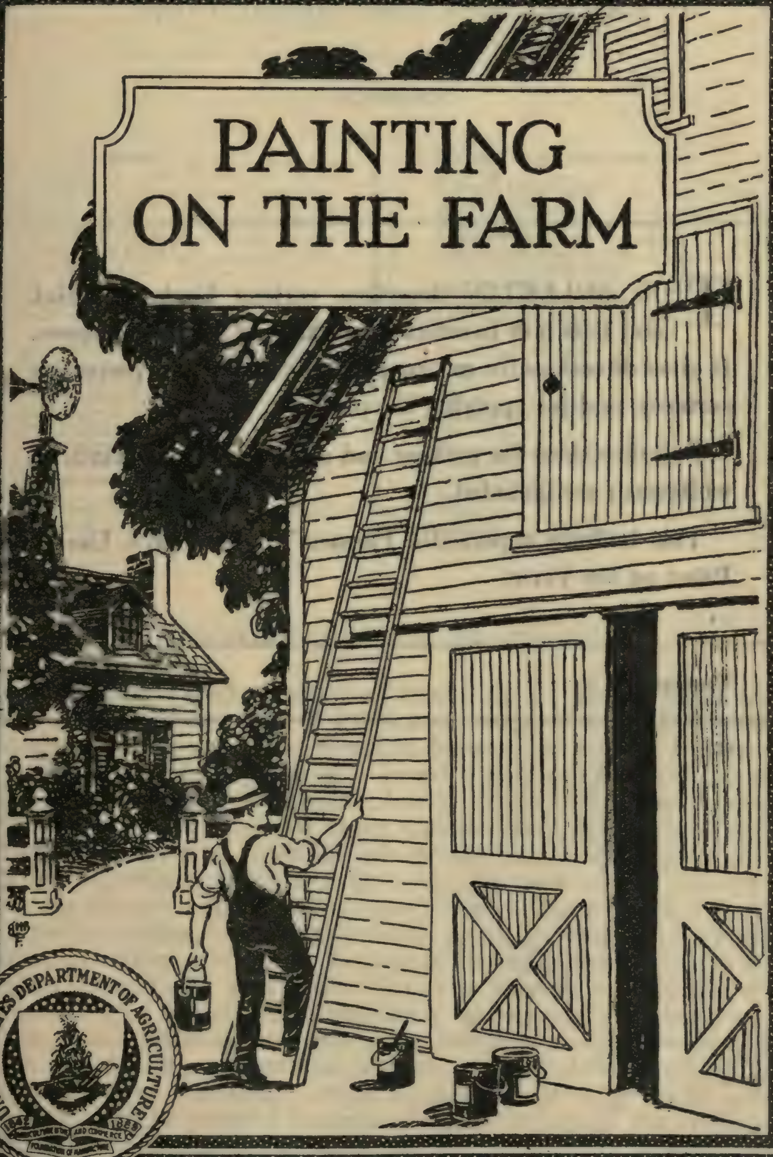
FARMERS' BULLETIN No. 1452

PAINTING ON THE FARM



THIS BULLETIN describes various kinds of paint and tells how to select the right kind for any purpose. It gives directions for mixing paint on the job, for preparing surfaces, and for applying the paint.

Full directions for making and applying several kinds of whitewash are included.

This bulletin supersedes Farmers' Bulletin 474, Use of Paint on the Farm.

Washington, D. C. Issued April, 1925

PAINTING ON THE FARM

By H. P. Holman, *Chemist, Bureau of Chemistry*

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IMPORTANCE OF PAINTING

ALTHOUGH a coat of paint adds greatly to the appearance of a building or a piece of farm machinery, the chief purpose of painting on the farm is to preserve houses, barns, and implements from the effects of the weather. Interior painting is usually done to make the home more attractive, but it also serves a useful purpose in making walls and ceilings more sanitary and dark rooms lighter.

The importance of painting has grown as the increasing cost of building materials has made it necessary to replace with less durable materials the wood and metal formerly used. Some woods, like white pine, yellow poplar, cypress, and cedar, and some metals, like wrought iron, zinc, copper, and brass, withstand the effects of exposure to the weather remarkably well and will last a long time with few or no applications of paint. The materials widely used to-day, such as yellow pine, cast iron, and the more common steels, however, deteriorate rapidly on exposure and need to be painted frequently. Even sheet iron that has been tinned or galvanized to prevent rusting usually should be painted because of imperfections in the coating.

Painting at regular intervals is the cheapest way to keep buildings and implements in good condition.

WHEN TO PAINT

Painting should not be put off too long. If wood has begun to rot or iron has begun to rust, the rotting and rusting will continue after the paint has been applied. Moreover, the longer painting is delayed, the more difficult and expensive it becomes. Painters often spend more time and effort in preparing surfaces that have been too long neglected than in painting them.

New wooden buildings should have a priming coat of paint as soon as the weather permits; their finishing coats should be put on within the next month or two. Tinned roofing should be painted as soon as it has been laid. Galvanized sheet iron may be allowed to weather for a year, usually with no injurious effects, to give paint a better foothold. Both the wooden and metal parts of implements and machinery should be painted before they are exposed to the weather or to a damp atmosphere. All surfaces should be repainted as soon as they show signs of being imperfectly protected. The durability of paint depends upon its composition, the kind of surface to which it is applied, and the conditions to which it is exposed. Outside painting usually does not give satisfactory protection for more than from three to five years, and sometimes not for as long as that.

Although spring and fall are the favorite seasons for outside painting, it is not necessary to put it off if the need for it becomes apparent in the summer or winter. Outside painting can be done whenever the surfaces are dry and the weather is not damp, frosty, or freezing. Best results are obtained when the temperature is between 60° and 80° F. Painting can be done in heated buildings at any time. Cool, dry weather is best for calcimining, however.

PAINT MATERIALS

All paint, whether it is bought ready mixed or mixed on the job, consists of a solid (the pigment) in a liquid (the vehicle). The pigment, a very finely divided solid, gives the paint its power to hide and color a surface. The vehicle makes it possible to spread the pigment over the surface, and upon drying binds the pigment particles to the surface and to one another. As a rule both pigment and vehicle are mixtures.

PIGMENT

Materials which make up the greater part of the pigment mixture are called base or body pigments. All light-colored or tinted paints have a white base. Dark paints may contain a dark base pigment mixed with other pigments, or they may contain only one dark pigment. The pigments other than the white pigment in a light-colored paint are known as the color or tinting material.

WHITE PIGMENTS

White lead.—Practically all light-colored paints for outside surfaces contain white lead, usually mixed with smaller quantities of other pigments.

Originally white lead meant basic carbonate of lead, but within recent years the term has been applied also to basic lead sulphate, originally called sublimed white lead. When used alone, each of these pigments gives a comparatively soft paint film, which becomes chalky on weathering. The carbonate is darkened rapidly when exposed to air containing sulphide gas and is readily dissolved by acids. If taken into the human system by breathing in the dust caused by sandpapering painted surfaces, it may cause lead poisoning or colic. The basic sulphate is less readily darkened by sulphide gas and is somewhat less poisonous than the carbonate.

Ground in linseed oil to a heavy paste, white lead can be bought almost anywhere in 12½, 25, 50, or 100 pound kegs and also in 300 and 500 pound casks. One or five pounds can usually be bought in compression-top cans. The cost per pound increases as the size of the package decreases. Dry white lead, which is handled by some dealers, is used in making lead putty, but not often for mixing paints.

Lead sulphate.—Ordinary sulphate of lead (not basic), which is white, sometimes forms part of ready-mixed paints. It is much less poisonous than the carbonate and is not darkened by sulphide gas. It does not hide surfaces as well as the basic carbonate and basic sulphate of lead, however.

Zinc oxide.—Zinc oxide (zinc white) is added to white lead in most ready-mixed white and light-colored paints to give a harder and more durable paint film. As its films are very hard and soon crack on weathering, it is not used alone in outside oil paints, but commonly forms from 25 to 50 per cent of the total pigment.

The higher grades of zinc oxide, produced from metallic zinc by the so-called French process, are whiter than white lead and are frequently used in outside white paints and in first-class enamels. The lower grades of zinc oxide, produced directly from zinc ore by the so-called American process, are tinged with yellow and usually contain lead sulphate. The color of zinc oxide is not noticeably changed by exposure to sulphide gas.

Both the dry pigment and the paste, in 1 and 5 pound cans, are sold by many paint dealers. As a rule, the higher grades are too expensive to be used in the preparation of ordinary house paints, and the cheaper grades are sold by comparatively few dealers. Zinc oxide packed in kegs like white lead is sometimes sold under trade names.

Lithopone.—Lithopone (about 30 per cent of zinc sulphide and 70 per cent of barium sulphate) is used principally in flat-finish wall paints and interior enamels. One of the chief objections to its use in outside paints has been that it turned dark gray when exposed to direct sunlight. Several brands which are said to be unaffected by light are now being manufactured. Some authorities hold that exposure to the weather causes the zinc sulphide in lithopone to change to the soluble zinc sulphate, which would be removed from paint films by rain. Lithopone is sold in retail paint stores only as ready-mixed paint.

Miscellaneous white pigments.—Titanium oxide, which has not yet come into extensive use, is not discolored by sulphide gas, is not poisonous, and is said to be satisfactory when properly mixed with other pigments. Titanox is a mixture of titanium oxide with a larger proportion of barium sulphate. Antimony oxide is said to be satisfactory when properly mixed with other pigments, but, because of its high cost, it is not commonly used.

Inert pigments or extenders.—Substances which appear to be white when in the form of a dry powder but are transparent in oil are sometimes added to ready-mixed paints as fillers or extenders. The legitimate purpose of such extenders, often referred to as inert pigments, is to prevent the settling of the pigment, to reduce the tendency of a paint film to chalk on weathering, and to serve as a base for highly-colored artificial pigments. Some of the colored pigments which occur in nature contain large proportions of such material. Excessively large quantities of inert pigments are sometimes used merely to cheapen paint.

Silica and the insoluble compounds of calcium, barium, magnesium, and aluminum are commonly used as extenders. Some of these compounds, which are also used in making colored pigments, may find their way into paints because they are present in the tinting material. More than 15 per cent, on the basis of total weight, in a white or light-colored paint is not accepted in Government purchases.

The most important of the calcium compounds is the carbonate, used in the form of natural chalk (whiting), precipitated chalk, and marble dust or flour. While not used in large quantities in oil paints, calcium carbonate, as whiting, is usually the base pigment for calcimines and cold-water paints. Whiting is also mixed with raw linseed oil (about 5 parts to 1 part by weight) to make glazing putty. Calcium sulphate may be introduced into a paint by using Venetian red or by adding gypsum (terra alba), burnt gypsum (plaster of Paris), or dead burnt gypsum. Sometimes calcium sulphate forms the base pigment of cold-water paint.

Barium sulphate, which is found in many ready-mixed paints, may be added in the natural form (barytes, barite, heavy-spar) or as chemically prepared blanc fixe (permanent white). Barium sulphate properly forms a large part of lithopone, titanox, and some highly-colored pigments, such as imitation vermilions and chrome greens.

Magnesium silicates (soapstone, talc, asbestine) are frequently used as extenders and sometimes serve as the base for pigments prepared from organic dyes (lakes). Aluminum silicates, including kaolin or China clay, are also frequently used. Silica (silex) is used either in the form of pulverized quartz or sand or in the natural mineral form of tripolite. Sometimes the general term silicates is used to cover silica and the silicates of magnesium and aluminum.

COLORED PIGMENTS

Colored pigments are added to white pigments to produce tinted paints; they are also used without white pigments to produce dark paints. As a rule, tinted and dark paints give better service than white paints, under the same conditions of use and exposure.

Tinting pigments.—Yellow pigments include the chrome yellows and the yellow ochers. Medium chrome yellow is lead chromate; light chrome yellow is lead chromate and lead sulphate; orange chrome yellow is a basic lead chromate. Yellow ochers are natural earths colored with hydrated ferric (iron) oxide or similar mixtures produced artificially. The better grades, such as French ocher, are high in silica; the poorer grades are high in clay (aluminum silicates). Chrome yellows give the brighter tints; good ochers give the more permanent tints.

The brown pigments include raw sienna and raw and burnt umber, which are natural earths, high in silica, colored with oxides of iron and manganese. The proportion of manganese in siennas is usually low. Both sienna and umber give permanent tints with white bases. Raw sienna is yellowish brown, giving cream tints; raw umber is greenish brown, giving drab tints; and burnt umber is a deep, rich brown. Burnt sienna, a reddish-brown pigment, is used more often to stain or grain wood than to tint paints.

Most red pigments owe their color to the presence of ferric oxide (iron sesquioxide), which is very lasting. Indian red is almost pure ferric oxide; Venetian red consists of ferric oxide and a large proportion of calcium sulphate, calcium carbonate, or complex silicates. Organic colors (dyes), combined with inorganic substances in the form of the so-called "lakes," are sometimes used for tinting, but the tints are usually not permanent.

The black pigments owe their color to the presence of carbon. Lampblack and carbon black are almost pure carbon; bone black (ivory or drop black) consists of calcium phosphate and calcium carbonate, colored with carbon.

Of the blue pigments, Prussian blue (ferric ferrocyanide) is injured by lime and alkalies, and ultramarine blue (a complex thiosilicate) is broken down by acids. Ultramarine is used in water paints and for tinting paints having a base of lithopone or zinc oxide. Sometimes it proves unsatisfactory when used with basic carbonate white lead. Tints obtained with Prussian blue fade on exposure to light. In ready-mixed paints Prussian blue may sometimes be almost decolorized in the can, but the color will reappear as the paint dries on the surface to which it is applied.

The only green pigments commonly used in tinting are the chrome greens (mixtures of Prussian blue and chrome yellow). Medium chrome green is used most. Dark chrome green contains an excess of blue; light chrome green contains an excess of yellow, with lead sulphate or inert pigments. Tints obtained with chrome greens fade on exposure to light and are injured by lime and alkalies.

Tinting colors ground in linseed oil are generally available in 1 and 5 pound cans; some come also in 12½ and 25 pound cans. Lampblack and Prussian blue may be bought in quarter-pound or half-pound cans. The colors commonly used in tinting house paints are sold in small cans and collapsible metal tubes by dealers in supplies for artists, decorators, and sign painters. When only a trace to a quarter of a pound of colored pigment is needed, it is well to use colors in collapsible tubes. A full-size artists' tube is about 1⅛ by 3½ inches and holds about 2 ounces. The half-size tube holds about an ounce. Decorators' colors come in tubes 1¼ by 6 inches, which hold about 4 ounces.

Dry pigments are sometimes available for tinting water paints, cement, and putty, but they are not suitable for tinting oil paints.

Body pigments.—Some colored pigments, which are rarely used for tinting, are valuable as body pigments or self colors. Among these, red lead (oxide), orange mineral (a special high grade of red lead), sublimed blue lead, and American vermilion (a specially prepared basic lead chromate) are used in paints designed to keep iron from rusting. Red lead is usually available in dry form and sometimes also as an oil paste, packed in the same way as white lead. As a rule, the

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Usage

dry pigment contains yellow oxide of lead (litharge), which makes the paint thicken several hours after it has been mixed.

Tuscan red is an Indian red enriched with an organic dye. Lightfast imitation vermilions (bright red paints designed for solid-color painting) consist of organic dyes, such as para red and toluidine red, on barium sulphate or silicate bases. Venetian red and red iron oxide, both comparatively cheap, are sometimes used as body pigments in dull red paints. Brick-red pigments are usually mixtures of Venetian red and yellow ocher, both of which are commonly available in dry form. The mixture comes also in paste form. Yellow ocher mixed with linseed oil is sometimes used as a priming coat on wood, but it is not suitable for this purpose.

Brown metallic, a natural iron oxide, is a cheap but excellent pigment, commonly used in paints for barns, bridges, roofs, and other places where its color is not objectionable. It is generally available in dry form and sometimes comes ground in linseed oil. The paste can be used more easily and gives a more uniform coating than the dry pigment.

The pigment in solid black paint is usually bone black (ivory or drop black) toned with Prussian blue. Black paints for metal sometimes contain graphite in combination with silicates, and sometimes carbon blacks are mixed with black oxide of iron or mineral blacks (ground slate or other dark mineral fillers). Bituminous substances, like coal-tar pitch or asphalt, and dark mineral fillers also make black paints.

The pigment in many yellow, green, and brown paints is largely barium sulphate or silicates, with enough tinting material to give the desired color and hiding power.

Distemper pigments.—Sienna, umber, ocher, Van Dyke brown, and other pigments are sometimes ground in water with a water-soluble binder to form the so-called distemper colors, which are used principally for graining.

VEHICLE

The vehicle in oil paints is usually linseed oil (sometimes mixed with varnish in ready-mixed paints), with a little liquid drier and thinner. The vehicle in enamels is essentially varnish.

PAINT OILS

Linseed oil is valuable as a paint vehicle because when it is exposed to the air it changes from a liquid to a transparent and flexible solid. China wood or tung oil, perilla oil, soya-bean oil, and other drying oils may be used in the manufacture of paints after they have received special treatments. Linseed oil, however, is the only suitable oil commonly available for mixing paint on the job.

Genuine kettle-boiled or bodied linseed oil is rarely found in retail paint stores. Ordinary boiled linseed oil, prepared by heating raw oil for a short time with a drier, is sometimes sold. Raw linseed oil, however, is the vehicle ordinarily used in outside paint mixed on the job. Boiled oil is sometimes used for mixing interior paints and priming coats put on to seal the pores of concrete, plaster, and brick.

Unless a paint oil is labeled "Linseed oil" the chances are that it is not the real thing. "Pure oil" and "boiled oil" do not necessarily mean linseed oil.

PAINT THINNERS

Thinners usually consist of turpentine or mineral spirits or a mixture of the two. The effect of a thinner is for the most part temporary; it evaporates when the paint is used. Thinners make the paint spread more easily and the oil penetrate porous surfaces more readily. If used in large quantities, thinners make oil paints less glossy, giving the surface a dull or flat finish.

Spirits of turpentine, which is generally available, is usually preferred for thinning oil paints. Wood turpentine is as serviceable as the more common gum spirits, unless it has not been properly refined, in which case it has a disagreeable odor and may cause paint to thicken or "liver." Mineral spirits is cheaper than turpentine and is satisfactory for thinning flat-finish wall paints and paints for metals. It is not as good as turpentine, however, for thinning paints to be used in priming resinous wood like yellow pine.

Ordinary gasoline and kerosene are not suitable for thinning most paints. Gasoline evaporates too quickly, kerosene too slowly. Kerosene is sometimes used for thinning creosote shingle stains, but solvent naphtha or benzol is better. Solvent naphtha and benzol are particularly well suited for thinning first-coat paints or stains to be used on new cypress wood, but, since their vapors are more poisonous than those from turpentine and mineral spirits, they should always be used with caution and never in closed spaces.

Thinners sold under the name of "Mineral turps" or "Substitute turpentine" are not really turpentine, but a cheaper material, usually straight mineral oil. Mixtures containing drying oil, volatile thinner, liquid drier, and sometimes other materials are sold for thinning paints. Some of these are satisfactory, but without definite knowledge of their composition or serviceability it is safer to use linseed oil, turpentine, and high-grade japan drier separately.

Flatting oil, sold for making dull-finish paints from white lead, is generally considered more satisfactory for this purpose than other thinners, because a larger quantity can be used without making the paint too thin.

Coal-tar creosote, which is used in mixing shingle stains, can be obtained from gas works and sometimes from paint stores.

PAINT DRIERS

Liquid driers contain substances which hasten the hardening of linseed or other drying oil. Oil driers are solutions of these substances in linseed oil. Japan driers are solutions of these substances and gums or resins in turpentine, benzine, or other liquid. When a drier is added to an oil paint the coat dries in one or two days; when no drier is added the paint may not dry for a week or longer. Too much drier shortens the life of any paint and, by causing rapid drying of the surface, may keep thick films from becoming perfectly hard as soon as they should. Japan drier made with turpentine is more popular than any of the other grades. Pale japan drier is desirable for white and light-tinted paints; dark japan is suitable for dark paints and shingle stains. Gloss oil, sometimes used as a drier, and "lightning" drier are inferior products.

READY-MIXED PAINTS

Ready-mixed paints put out by reputable manufacturers have certain advantages over paint mixed on the job. Most of them contain materials, not available for home mixing, which give paint desirable properties, particularly in meeting special requirements, and they are more uniform because mixing can be done more thoroughly by machinery than by hand. Just the desired quantity of ready-mixed paint may be bought; when paint is prepared on the job it is necessary to mix more tinted paint than will be needed or else take a chance on having to make a second lot to match the first, an almost impossible task for anyone who is not an expert. Ready-mixed paint of any particular shade can usually be bought at any time, a great advantage in matching paint to a surface previously painted and in making the color of additions or new buildings the same as that of old buildings. Although paper color cards frequently differ decidedly from the colors of the paints they represent, wooden sample panels show just how the colors will look when dry. The results of tinting to a desired color on the job are uncertain.

The composition of paint-making materials and of ready-mixed paint is stated on the containers in all the States which have laws requiring such a statement, and also in many States where it is not required by law. Although false and misleading labels are not as common as they once were, they are still found. Any label which fails to show the exact character of the material and any fancy name or the word "compound" printed with the name of a good paint material should be regarded with suspicion. If the name and address of the manufacturer do not appear on the label, the material in question is probably an adulterated product of poor quality, with which the manufacturer does not care to have his name associated.

A detailed statement of composition on the label of a ready-mixed paint is not proof that the paint will be satisfactory, even if the ingredients mentioned are commonly recognized as good paint materials. Such a statement, however, shows whether or not the paint contains an excessively large quantity of cheap substitutes for materials generally held to be good, and enables the purchaser to know whether or not a high price is being asked for a cheap product, or, if the price is low, to decide whether he is willing to take a chance on quality. In the long run it pays to buy the paint which is most likely to be serviceable, regardless of its price.

Ready-mixed paints should be used only for the purposes for which they are sold and in accordance with the manufacturers' directions. Paint in quart or smaller cans is usually mixed by vigorous shaking before opening. Paint in half-gallon or gallon cans must be stirred. As some pigment always settles, the liquid portion of the paint should be poured into another container and, after thoroughly stirring the thick portion, poured back, a little at a time, with stirring after each addition. More thinner, in the form of linseed oil, turpentine, or a mixture of the two, may be required for preliminary coats. Directions for thinning are usually given on the cans.

OUTSIDE HOUSE PAINT

Most ready-mixed house paints which are designed especially for use on wood contain white lead and zinc oxide, sometimes in equal quantities and again with only 10 to 40 per cent of zinc. White lead and zinc oxide together should form 85 per cent or more of the total pigment in white and light-colored paints. The pigment in such paints is usually 60 to 65 per cent of the total weight. The vehicle should be pure raw linseed oil, with just enough high-grade japan drier to properly dry the paint (from 5 to 10 per cent). Since linseed oil costs more, pound for pound, than many pigments, some paints have more pigment and less linseed oil. The quantity of volatile thinner, such as turpentine or petroleum spirits, should not make up more than 10 per cent of the vehicle. The addition of gloss oil, rosin oil, fish oil, and mineral oil makes inferior paints.

The net weight per gallon (231 cubic inches) of ready-mixed white and tinted outside paints varies from about 15 to about 22 pounds, being highest in an all-lead paint. Dark ready-mixed paints weigh 9 to 14 pounds per gallon.

FLAT WALL PAINT

The pigment base of most prepared flat-finish paints is lithopone, alone or mixed with zinc oxide. About 60 per cent by weight of these paints is pigment. The vehicle is about one-third nonvolatile matter (mixing varnish or treated tung oil and drier) and two-thirds volatile thinner (turpentine, benzine, or petroleum spirits), including that in the drier. Ready-mixed flat paints have more body than flat paints made by thinning paste pigments with turpentine or mineral spirits and are not so likely to spread or creep. Interior paints usually have more liquid drier (10 to 12 per cent) than outside paints.

FLOOR PAINT[1]

Exterior floor paints contain white lead and other pigments, such as litharge or zinc oxide, which harden the paint film. The vehicle usually contains hard-drying water-resistant varnish in addition to heat-treated drying oils. Interior floor paints may contain lithopone and zinc oxide, with varnish as the vehicle.

Exterior floor paints may be used also on wagons and agricultural implements.

ENAMEL

Enamel paints, designed principally for furniture and interior woodwork, are mixtures of pigment, usually zinc oxide or lithopone, with varnish. Most enamels dry with a high gloss; some give a satin or semigloss finish; and others dry without gloss.

Special undercoaters, usually white, sold for use under enamels, consist of opaque pigments mixed with a vehicle designed to give a flat finish.

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[1] Information on interior floor paints is given in U. S. Dept. Agr., Farmers' Bul. 1219.

SPECIAL PRIMERS AND UNDERCOATERS

Ready-mixed primers are sold for coating metals, brickwork, cement floors, plastered walls, etc. The pigment in them may be the same as that in the finishing coats, but the vehicle is usually designed to make the paint adhere, close the pores, and give a good foundation for the finishing coats. Some undercoaters contain silica or similar material in place of opaque pigments, which makes them practically transparent.

CONCRETE AND CEMENT PAINT

Heat-treated drying oils or varnish gums added to the vehicle give water resistance to the special flat-finish paints for concrete, cement, stucco, and brick surfaces. When special water resistance is unnecessary and a gloss finish is not objectionable, ordinary house paints may be applied to such surfaces over suitable priming coats.

RUST-PREVENTING PAINT

Paints consisting essentially of American vermilion are most effective in retarding the rusting of iron.[2] Other pigments are often added to modify the color, and heat-treated drying oils or varnish gums are usually added to give greater water resistance to the coat.

BITUMINOUS PAINT

Paints for composition roofing are made from bituminous materials, like coal-tar pitch or asphalt, mixed with mineral fillers. Other bituminous materials are frequently added, as well as heat-treated drying oils, varnish gums, resins, and other substances. The natural black or brown color of the bitumens may be modified by the filler, but only dark colors are possible. Sometimes bituminous materials come in both liquid and solid form, the first to be used as a priming coat and the second to be melted and applied hot in finishing.

Coal-tar paints should be used on composition roofing originally treated with coal-tar products; asphalt paints on composition roofing originally treated with asphalt products. Most bituminous materials soften when exposed to hot sunshine and may run on a steep roof. In cold weather they are usually brittle.

Bituminous roof paints may be used on metal roofs, but they are not as suitable as the special oil paints for metals.

Asphaltum varnishes and japan blacks are used on metals, and special bituminous paints are used for waterproofing, acid proofing, and electrical insulating. Paints and similar coatings can not be depended upon to make wood or iron as safe from injury by acids as are earthenware, glass, hard rubber, and acid-resisting metals.

MARINE PAINT

Deck paints are similar to paints used for porch floors. Marine paints for wooden surfaces above water, good for any wooden surface exposed to salt air, usually consist of white lead and a large proportion of zinc oxide. Red-lead paints are among the best for protecting metals exposed to salt air and they can also be used on wood.

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[2] Proceedings, American Society for Testing Materials, vol. 15 (1915), p. 218.

HEAT-REFLECTING PAINT

Weather-resistant aluminum paints or enamels are used on oil tanks and other surfaces where as much heat as possible is to be reflected. White or light-colored oil paints may also be used. Black and dark paints readily absorb heat, thus raising the temperature of the space beneath them.

PAINT FOR STEAM RADIATORS

Paints having a metallic luster, such as aluminum and gold bronze, often applied to steam radiators, may be bought ready mixed, or they may be prepared from the dry powder and bronzing liquid. Although these paints reduce heat radiation more than common paints and enamels,[3] they do not ordinarily interfere with effective heating.

AUTOMOBILE PAINT

The more permanent automobile finishes are usually obtained with baking japans or enamels, which are dried and hardened in ovens at high temperatures. These and other special finishes, which are fairly durable, can be applied only in factories. The materials sold for refinishing automobiles at home are usually colored pigments ground in japan for flat-finish undercoats and colored varnishes or enamels to be applied and dried at ordinary temperatures. Sometimes finishing coats of clear varnish are used, but a colored varnish usually makes a more durable finishing coat. Although good results are possible with the paints put out by reputable manufacturers, the finish obtained with automobile paints applied at home will not look as well or last as long as the original finish.

Special heat-resistant paints for engine hoods and radiators and special preparations for tops are also on the market.

"FIREPROOFING" PAINT

Fireproofing qualities are claimed for certain ready-mixed oil and water paints. Although some paints may resist fire more than others, no paint can make wood really fireproof. Ordinary paints reduce somewhat the danger of fire from sparks, cinders, and small burning bits of material, because they prevent the porous and fuzzy surfaces found on unpainted and weather-beaten wood. Special "fireproof" paints burn somewhat less readily than ordinary paints or contain substances which fuse under the influence of heat.

Fire-retarding paint should contain as little oil as possible, and lead and zinc pigments should be largely replaced by fusible, incombustible, and insoluble substances. Most substances that have fire-retarding qualities are soluble in water and soon leach out of paint films exposed to the weather. Powdered boric acid makes a paint more resistant to fire than it would otherwise be, for a short time. The use of pulverized zinc borate in preparing fire-retardant paints has been recommended by the United States Forest Service.

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[3] Journal American Society of Heating and Ventilating Engineers, vol. 26 (1920), p. 103.

LUMINOUS PAINT

Special coatings are sometimes used to make small objects visible in the dark. Such preparations are made for manufacturers and are not generally available to the public.

The most satisfactory paints of this kind owe their luminosity to an exceedingly small quantity of a radium compound or other radioactive material in the presence of a large quantity of radio-responsive crystals, such as zinc sulphide, applied and sometimes coated with a transparent adhesive or varnish. Such paints may be luminous for 10 years or longer. Other luminous paints are made from specially prepared impure sulphides of calcium, strontium, or barium. These paints, however, are luminous only under certain conditions and only for short periods immediately after exposure to sunlight. Luminous paints can not be made from phosphorus, and any attempt to do so is extremely dangerous.

CALCIMINE AND COLD-WATER PAINTS

As materials for making calcimine and cold-water paints are not always easy to buy and the ready-mixed paints are comparatively cheap, it is more satisfactory to buy them than to prepare them.

Calcimine and cold-water paints contain a lime compound (calcium carbonate or calcium sulphate) and an adhesive substance, which acts as a binder. In some cold-water paints the adhesive is casein, which is practically insoluble in water after the paint dries. Although coatings of such paints may be called "waterproof" in so far as they are not readily removed by water, they do not prevent moisture from reaching the surface beneath. When used out of doors they give little protection.

VARNISHES

Many of the varnishes sold by paint dealers are for special purposes. All-purpose or universal varnishes are the best unless the kind needed is known, but they often cost more than special varnish. As a rule, varnish intended for a particular purpose should be used for no other purpose. Varnishes of different kinds should not be mixed. They should be thinned as directed on their labels. Many varnishes will "liver," or become semisolid, when mixed with the common white pigments.

PAINT MIXED ON THE JOB

The chief advantage of paint mixed on the job over that bought ready mixed is its comparative cheapness. Before mixing is begun the quantity of paint needed should be estimated (p. 23) and all necessary materials and equipment obtained.

EQUIPMENT

All receptacles used in mixing paint must be clean, dry, and watertight.

The receptacle in which house paint is mixed should be large enough to hold all of the stock paint, that is, all the pigment and about half the linseed oil required to make it suitable for a finishing coat. Fiftypound lard cans or tubs or 300-pound white lead casks are usually big enough. Larger quantities of paint may be mixed in a wooden cask or half a vinegar barrel. A 100-pound white-lead keg is large enough for mixing a gallon or two. Before being used the cans or kegs should be thoroughly washed with hot soap solution or soda lye to remove all grease or dried white lead.

Containers with tight-fitting covers, like lard cans, which keep the contents clean and away from the air, are better than open cans or pails for storing paint after it has been mixed. Enough gallon cans, with air-tight compression tops, to hold all of the paint of each color are desirable.

Broad, flat paddles are convenient for handling the paste pigments and stirring the paint, and a paint-mixing machine is a great help when much painting is to be done. Cheesecloth or fine-mesh wire screen should be provided for straining the paint just before it is used.

A pint or quart container is needed for measuring linseed oil and volatile thinner, and a half-pint glass cup, marked off in fractions, is convenient for measuring small quantities of japan drier.

MIXING

In mixing white-lead paint, transfer the lead paste to the can or keg and measure into another container all the linseed oil that will be needed for the stock paint. Then begin to break down the lead paste by adding about half a pint of oil and working it in thoroughly with a paddle. Continue to add oil, a little at a time, mixing thoroughly with the paddle after each addition, until the paste is smooth and workable. Then work in the japan drier and turpentine in the same way, keeping the rest of the oil until after tinting.

In mixing a lead-and-zinc paint, measure the lead, zinc, and oil into separate containers. First break down the lead paste with part of the linseed oil, drier, and turpentine. Then break down the zinc paste in the same way. Mixing a little refined linseed oil or bodied linseed oil (about 1 pint for 50 pounds of zinc paste) with the raw linseed oil makes the operation easier. Add bodied linseed oil, if used, with the turpentine and drier, early in the breaking-down process. Finally add the zinc to the lead.

To make both a white and a tinted paint or two tinted paints, divide the partly thinned paste into two portions having the proper ratio. That is, if one part of trim color is needed for five parts of body color, put one-sixth of the paste in one container and five-sixths in another. Then tint one or both portions of the paste. After tinting, divide what is left of the linseed oil measured out for the stock paint into two parts having the same ratio as the divided paste and add each part to the corresponding portion of paste.

Stir each lot of stock paint thoroughly until the color and consistency are uniform. Mixing is hastened by "boxing," that is, pouring the paint back and forth from one container to another.

Finally strain each lot through wire fly screen or several thicknesses of cheesecloth and keep it in tightly-covered containers. This stock paint should stand for at least a day, after which it should be thinned before it is applied to any surface. Skin or coarse particles should always be removed by straining the paint.

TINTING

One or more tinting pigments may be added to the stock paint. The quantity required depends on the tinting power of the pigment and the depth of color desired (p. 26).

Break down or thin the paste color with linseed oil or turpentine before adding it to the white base. Mixing can be done best while the white base is still a heavy paste. Add only a little color at a time, stirring it in thoroughly before adding any more. If more than one color is used, it is better to make small additions of each in turn than to complete the addition of one before starting with another. Often the desired color is obtained before all the tinting material prepared has been used. The tint will be somewhat lighter when the paint is thinned for use.

OUTSIDE HOUSE PAINT

WHITE-LEAD PAINT

Stock paint (to make 7 gallons of paint when thinned)

White-lead paste	pounds	100
Raw linseed oil	gallons	2
Japan drier	pint	1
Turpentine	pint	1

After mixing (p.13), divide according to the number and quantity of colors needed and tint before thinning.

Paint for a three-coat job.—Divide the stock paint of each color into three equal parts. If the trim color is to be used only for second and third coats, divide and thin the stock paint for trim as described for a two-coat job. Thin the first part with three-fifths its volume of a mixture of linseed oil and turpentine in equal parts. Thin the second part with three-tenths its volume of turpentine. Thin the third part with three-tenths its volume of linseed oil.

Paint for a two-coat job.—Divide the stock paint of each color into two equal parts. Thin the first part with two-fifths its volume of turpentine. Thin the second part with two-fifths its volume of linseed oil.

LEAD-AND-ZINC PAINT

Stock paint A (to make 6 gallons of paint when thinned)

White-lead paste	pounds	50
Zinc-oxide paste	pounds	25
Raw linseed oil	gallons	2⅛
Japan drier	pint	1
Turpentine	pint	1

Stock paint B (to make 5 gallons of paint when thinned)

White-lead paste	pounds	50
Zinc-oxide paste	pounds	12½
Raw linseed oil	gallons	1⅞
Japan drier	pint	¾
Turpentine	pint	¾

To make a white paint, use refined linseed oil, which has been specially treated to lighten the color, instead of the raw oil, and pale japan instead of the ordinary dark drier.

After mixing, divide the stock paint (A or B) according to the number and quantity of colors needed and tint.

Paint for a three-coat job.—Divide the stock paint of each color into three equal parts. Thin the first part with two-fifths its volume of a mixture of linseed oil and turpentine in equal parts. Thin the second part with one-fifth its volume of turpentine. Thin the third part with one-fifth its volume of linseed oil.

Paint for a two-coat job.—Divide the stock paint of each color into two equal parts. Thin the first part with one-fourth its volume of turpentine. Thin the second part with one-fourth its volume of linseed oil.

SPECIAL THINNING

Conditions sometimes make it necessary to change the proportions of linseed oil and turpentine for thinning paints made according to the foregoing directions. When special thinning is required, add the oil or turpentine, a little at a time, to the stock paint and stir well after each addition. When the paint seems to be thin enough make a brushing test on the surface to be painted.

First-coat paint for unpainted wood should contain enough turpentine to make the oil strike in well and enough linseed oil to satisfy the absorption of the wood. On resinous wood like yellow pine, which is not very absorbent, the proportion of turpentine in first-coat paint should be increased and the proportion of linseed oil decreased. The priming coat for cypress should be thinned with benzol. The first coat should color the wood fairly well, but should not hide the surface completely. It should dry flat, that is, with no gloss. If it dries with a gloss, too much oil has been added.

The second coat for new wood should brush out easily, but it should almost entirely hide the surface. It should dry flat or with very little gloss. If too much thinner is used, the second coat will be too transparent. If too much oil is added, the paint will be glossy when dry, making an unsatisfactory foundation for the finishing coat.

The final coat should not be too thick; neither should it be thinned so much that it fails to hide the surface. Since the final coat must dry with a full gloss to be weather resistant, no turpentine or other volatile liquid should be added to that already in the stock paint. Only linseed oil should be used for further thinning.

In repainting badly weather beaten surfaces, it may be neccssary to add to the first-coat paint more oil than is usually required in a two-coat job. Such surfaces need three coats.

INTERIOR PAINT

FLAT-FINISH PAINT

Since flat-finish paints are thinned principally with volatile liquids, which permit the pigments to settle rapidly and which evaporate on exposure, each lot of paint should be prepared as it is needed. If more than one color is necessary, divide the base pigment after it has been brought to a smooth working condition and tint before more thinner is added.

Priming coat on unpainted plaster (2½ gallons)

White-lead paste	pounds	25
Raw linseed oil	gallons	1¾
Japan drier	pint	¾
Turpentine	pints	2

If kettle-boiled linseed oil is available, use it instead of raw linseed oil, and substitute additional turpentine for japan drier.

This paint is designed to fill the pores and fine cracks in unpainted plaster. It is best to follow it with good varnish size (p. 23).

First coat over priming coat, old paint, or wall size (1½ gallons)

White-lead paste	pounds	25
Raw linseed oil	pints	3
Turpentine	pints	3
Japan drier	pint	¼

This paint may be used as the first coat of a two-coat job on surfaces which have been painted or sized, or as the second coat of a three-coat job.

Finishing coat (1½ gallons)

White-lead paste	pounds	25
Flatting oil	gallon	½ to ¾

If flatting oil is not available, use 3 to 5 pints of turpentine, adding one-eighth pint of japan drier.

This paint is suitable for finishing coats when a flat finish is desired and for undercoats before enameling. The smaller quantity of thinner is sufficient for a finishing coat over only one coat of paint or for an undercoat for enamels where not more than two undercoats are desired.

GLOSS-FINISH PAINT

To make a colored paint with an oil gloss, mix according to formulas for outside house paint (p. 14). White paints having linseed oil as the principal vehicle are not suitable for interiors because they become yellow when shaded from sunlight. To obtain a high-gloss finish suitable for kitchens and bathrooms use a good enamel paint. It is not usually practicable to mix enamels on the job.

BARN PAINT

BARN PAINT NO. 1 (5½ GALLONS)

Metallic oxide ground in linseed oil	pounds	50
Raw linseed oil	gallons	2½
Japan drier	pints	1½

BARN PAINT NO. 2 (7 GALLONS)

Metallic oxide, dry	pounds	50
Raw linseed oil	gallons	5½
Japan drier	pints	2

Allow the paint to stand for a day or longer. When ready to apply, stir it thoroughly; also stir occasionally while painting. Paint made in this way is suitable for surfaces that have been painted and are not porous and weather beaten. For priming new wood or for a first coat on painted wood that has become porous, thin the paint with linseed oil and turpentine (or mineral spirits), mixed in equal parts. Paint prepared from dry pigment costs less than that prepared from paste, but it is more difficult to mix, settles out more rapidly, and is not as smooth and uniform.

PAINT FOR BRICK AND CONCRETE

At least three coats should be applied to unpainted brickwork. Best results are obtained if the first coat is mixed with kettle-boiled linseed oil (p. 6). It is well to apply three coats to soft brick surfaces before putting on the finishing coat. The third coat should be like the second.

LIGHT PAINT

Light-colored paints for brick or concrete may be made according to the following formulas, adding lampblack, raw sienna, and French ocher to get tints of gray, cream, or buff.

First coat (about 10½ gallons)

White lead in oil	pounds	100
Raw linseed oil	gallons	6½
Japan drier	pints	2
Turpentine	gallon	1

If kettle-boiled linseed oil is available, use it instead, omitting the japan drier.

Second coat (about 7½ gallons)

White lead in oil	pounds	100
Color in oil		As required.
Raw linseed oil	gallons	4½
Japan drier	pints	1½
Turpentine	pint	1

If kettle-boiled linseed oil is available, use 1 part of it to 2 parts of raw oil, and reduce the quantity of drier to 1 pint.

Finishing coat, flat (about 6 gallons)

White lead in oil	pounds	100
Color in oil		As required.
Flatting oil	gallons	3
Japan drier	pint	½

If flatting oil is not available, use about 2¼ gallons of turpentine.

Finishing coat, semiflat (about 6 gallons)

White lead in oil	pounds	100
Color in oil		As required.
Raw linseed oil	gallon	1
Turpentine	gallons	2
Japan drier	pint	½

RED PAINT

Red paint for bricks may be made according to the following directions, varying the proportions of red and yellow pigments as desired.

First coat (about 9 gallons)

Venetian red in oil	pounds	25
Yellow ocher in oil	pounds	25
Raw linseed oil	gallons	5
Japan drier	pints	2
Turpentine	gallon	¾

If kettle-boiled linseed oil is available, use it instead of raw linseed oil, omitting the japan drier.

Second coat (about 6¼ gallons)

Venetian red in oil	pounds	25
Yellow ocher in oil	pounds	25
Raw linseed oil	gallons	3
Japan drier	pints	1½
Turpentine	pint	1

If kettle-boiled linseed oil is available, use 1 gallon of it to 2 gallons of raw oil and reduce the quantity of drier to 1 pint.

Finishing coat (about 5¼ gallons)

Venetian red in oil	pounds	25
Yellow ocher in oil	pounds	25
Flatting oil	gallons	2
Japan drier	pint	½

If flatting oil is not available, use about 1½ gallons of turpentine.

OUTSIDE PAINT FOR METALS

Good paints for metal surfaces may be prepared by mixing red lead (p. 5) or sublimed blue lead (p. 5) ground in oil with linseed oil and drier according to directions on the kegs in which the pigments are sold. Paint from dry red lead should be mixed in the following proportions just before it is used:

Red lead, dry	pounds	50
Raw linseed oil	gallons	1¾
Oil drier	pint	1

This will make 2½ gallons of red lead paint.

To make a cheaper paint, mix red or brown metallic pigment, linseed oil, and drier according to the directions for barn paint given on page 16.

The finishing coats for oil tanks and other structures which need protection from the sun's heat should be white or light colored. They may be mixed like outside house paints (p. 14). Aluminum paint may be prepared by mixing aluminum bronzing powder, preferably polished, with good outside spar varnish in the proportion of 2 pounds to the gallon. Add the varnish to the dry pigment, a little at a time, stirring well after each addition.

FARM IMPLEMENT PAINT

Paint for farm machinery and implements should dry harder and give a more water-resistant coat than the ordinary house paints. Pigments ground in japan or coach-painters' colors, mixed with varnish and thinner, are better than the ordinary paste pigments mixed with linseed oil alone.

The pigment may be a single color or a mixture of colors. Indian red, drop black, light chrome green, and medium chrome yellow are good pigments for self colors. Zinc white, or a mixture of white lead and zinc containing at least one-half zinc, is a suitable base for grays and other light tints. Before proceeding with the mixing, it is advisable to mix small quantities of the pigment and vehicle to see if mixing can be accomplished without livering. It may be necessary to change either the pigment or the vehicle.

FARM IMPLEMENT PAINT NO. 1

First coat (¾ to ⅞ gallon)

Pigment ground in japan	pounds	5
Outside spar varnish	pint	1
Turpentine	pints	3

Second coat (¾ to ⅞ gallon)

Pigment ground in japan	pounds	5
Outside spar varnish	pints	3
Turpentine	pint	1

FARM IMPLEMENT PAINT NO. 2

First coat (⅝ to ¾ gallon)

Pigment ground in linseed oil	pounds	5
Coach painters' japan[4]	pint	1
Turpentine	pints	2

Second coat (⅝ to ¾ gallon)

Pigment ground in linseed oil	pounds	5
Coach painters' japan[4]	pints	2
Turpentine	pint	1

Paint made by these formulas may be used for repainting implements and machinery while the original paint is still in place. Parts that are entirely free from paint should have three coats.

Red lead or sublimed blue lead, mixed with a little linseed oil, japan drier, and enough turpentine to dry flat, is good for priming metal and, with a somewhat higher proportion of linseed oil, can also be used for priming wood. These pigments, mixed with linseed oil and japan drier, may be used for finishing coats. In the absence of such paints, the uncoated metal parts can be primed with the first-coat paints in formulas 1 and 2, using a little more turpentine, and the wood can be primed with white lead and zinc oxide, tinted as desired, or with any other pigment, mixed with a little linseed oil, japan drier, and enough turpentine to dry flat. The addition of litharge (about 15 per cent of total pigment) is advisable.

SHINGLE STAINS

To make creosote stains, thin pigments ground in linseed oil with a vehicle consisting of 2 volumes of raw linseed oil, 2 volumes of turpentine or mineral spirits, 2 volumes of coal-tar creosote, and 1 volume of brown japan drier.

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[4] Not ordinary japan drier, but a hard-drying varnish, heavily charged with drying compounds, which can be used in any proportion with linseed oil.

For a dark-brown stain, add either burnt umber or Indian red, darkened with lampblack. For a green stain, add pure medium chrome green, modified with chrome yellow, yellow ocher, raw sienna, or lampblack. The quantity of pigment needed varies with the color. Ten gallons of a dark-brown stain from Indian red and lampblack calls for about 50 pounds of red pigment and 5 pounds of lampblack, with 7 gallons of the mixed vehicle. Twenty pounds of chrome green with 7 gallons of vehicle will yield about 8 gallons of stain.

Shingle stains can also be prepared from dry pigments, but the mixing is more difficult, and the pigments, being less finely ground, are more likely to settle, producing mottled or streaky effects.

WHITEWASH

COMMON WHITEWASH

Slake fresh quicklime of good quality with clean water, added a little at a time, in a clean wooden pail, keg, or barrel. Slaking may be hastened by breaking up some of the lumps or by adding a little hot water. When slaking is well started, add more water gradually to replace that lost in the slaking process. If not enough water is used the lime will become "scorched," and part of it will be granular. On the other hand, too much water may retard or "quench" the slaking process. After the lime is completely slaked, add enough water to make a thick paste, cover the container with boards to keep in the heat, and let it stand for several hours or over night. Then strain the paste through wire fly screen, and thin it to brushing consistency with clean water.

Whitewash can be more easily prepared by simply adding water to hydrated lime that has been well protected from the air. Hydrated lime, however, is not always available.

SPECIAL WHITEWASHES[5]

Whitewash No. 1 (for sheds, etc.).—Carefully slake half a bushel (38 pounds) of good quicklime; strain the paste, while still thick, through wire fly screen and add it to a solution made by dissolving 15 pounds of common salt in 7½ gallons of water, mixing thoroughly. Thin with more water.

Whitewash No. 2 (for sheds, etc.).—Carefully slake half a bushel (38 pounds) of good quicklime; strain the paste, while still thick, through wire fly screen and add about 4 gallons of hot water. While stirring vigorously pour into the lime mixture a solution made by first dissolving 12 pounds of salt and 6 ounces of alum in about 4 gallons of hot water and then adding 1 quart of molasses. Thin with water.

Whitewash No. 3 (for high-grade work).—(*a*) Carefully slake half a bushel (38 pounds) of good quicklime; strain the paste, while still thick, through wire fly screen, add about 4 gallons of water, and allow to cool. (*b*) Dissolve 3 pounds of borax (better trisodium phosphate) in about 3 gallons of skimmed milk (better in 1 gallon of water, which is afterwards added to 5 pounds of casein previously softened for 2 hours in 2 gallons of hot water). (*c*) Dissolve 3 pints of formaldehyde in about 3 gallons of water.

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[5] Based on formulas in National Lime Association Bulletin 304–B, "Whitewash and Cold Water Paint."

When the lime paste (*a*) and the milk (or casein solution) (*b*) are thoroughly cool, slowly add the milk (or casein solution) (*b*) to the lime (*a*), stirring constantly. Just before using, slowly add the formaldehyde solution (*c*) to the batch, stirring constantly and vigorously. Adding the formaldehyde too rapidly may cause the casein to jelly, thus spoiling the mixture.

Caution.—If all of this mixture can not be used in one day, use only half, or a third, or other fractional part of each of the three parts (*a*, *b*, and *c*), and mix the rest as required.

In all of these directions, one sack (50 pounds) of hydrated lime, which has been well protected from the air, can be used in place of the freshly slaked lime. In No. 1 the hydrated lime can be added directly to the salt solution; in Nos. 2 and 3 it should first be made into a paste by mixing it thoroughly with about 7 gallons of water.

Whitewash No. 4 (disinfectant whitewash).—For a mild disinfectant or insecticidal whitewash, add a quart of crude carbolic acid to the whitewash obtained by slaking half a bushel (38 pounds) of quicklime or by mixing a sack (50 pounds) of good hydrated lime with water.

For a strong germicidal whitewash, add 2 quarts of crude carbolic acid to the whitewash.

Whitewash No. 5 (disinfectant whitewash, small quantity).—Dilute 1½ quarts of commercial lime-sulphur with about 3 gallons of water and add 3 tablespoonfuls of common salt, previously dissolved in a pint of water. To this solution add, while stirring constantly, a lime cream made by mixing a heaping quart of good hydrated lime with water (or by slaking about 2½ pounds of fresh quicklime and straining through wire fly screen).

HOW TO PREPARE SURFACES FOR PAINTING

WOOD

New unpainted wood usually needs very little preparation. Dusting off loose dirt, removing mortar, plaster, or cement with a scraper or sandpaper, and filling nail holes and loose joints with putty after the priming coat is dry may be sufficient. If the wood is resinous or waxy or contains knots and coarse grain figures full of rosin or pitch, however, special treatment is necessary. Charring with a blowtorch will kill the pitch in knots, but the usual method is to apply a thin coat of orange shellac to all pitchy places before the surface is painted. Resinous wood like yellow pine should be brushed over with turpentine just before it is painted; cypress should be brushed over with solvent naphtha or benzol.

A painted surface that is simply chalky needs only to be dusted. All paint that has begun to scale or peel must be removed by scraping or brushing with a wire brush; more adherent paint that is checked may be softened with a blowtorch and then scraped off. All loose putty should be removed from nail holes, joints, and cracks, and fresh putty put in after the first coat of paint has dried.

Surfaces that have been varnished or enameled should be rubbed with fine sandpaper, curled horsehair, or fine steel wool until the gloss is removed. If such surfaces are marred, prepared varnish remover should be used,[6] smoothing the wood after it is dry with steel wool or sandpaper. Painted or varnished woodwork in kitchens and bathrooms should be washed with soap and water and then thoroughly sponged with clean water. Floors that have been treated with nonvolatile mineral oils can not be painted or varnished.

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[6] U. S. Dept. Agr., Farmers' Bul. 1219 gives further details for this work.

Shingles or other wooden surfaces that have been treated with creosote or creosote stains cannot be painted until they have weathered for several years.

Wood that has been whitewashed can not be painted until the whitewash has been removed as completely as possible.

Surfaces that have been coated with tar or other bituminous materials should be coated with shellac varnish before they are painted with oil paints. If soft, such surfaces should be coated with sand before they are painted or whitewashed.

BRICK AND CONCRETE

Old paint on brick surfaces is frequently loose, so that the surface must be gone over carefully and all paint which is not firmly attached to the surface scraped off. Before painting very porous bricks or similar materials which have never been painted, it is best to apply kettle-boiled linseed oil and oil drier or a special undercoater for sealing the pores of outside surfaces. A solution containing from 2 to 4 pounds of zinc sulphate to the gallon of water, carbonated ("soda") water, or ammonium carbonate solution should be applied to concrete, cement, stucco, mortar, and plaster made with lime, to neutralize free alkali, unless the surface has been exposed to the air for at least a year.

PLASTER

Wall paper should be removed from any plastered surface to be painted. Cracks and holes should be cut out so that they are wider on the inside than at the surface. Their edges should then be wet, and they should be filled with plaster of Paris or a mixture of plaster of Paris and whiting, adding sand for the rough first filling. When dry, patches in plaster which has been coated with oil paint should be covered first with thin shellac and then with one or two coats of flat oil paint before the entire surface is repainted.

Before either oil or water paints are applied to plastered surfaces, all old coats of calcimine, cold-water paint, or whitewash must be washed off as thoroughly as possible.

Wall-paper stains can usually be removed by washing walls with soda solution and sponging with clean warm water. All stains remaining after the walls are dry should be coated with shellac, varnish, or aluminum paint mixed with banana oil.

Unless the surface has been coated with oil paint or sized with a material insoluble in water, a preliminary sizing coat is necessary before calcimine or cold-water paint is applied. To make glue sizing, soak granulated glue in water for several hours, then heat it to boiling while stirring, and add enough water to make a thin sticky solution. Sometimes gloss oil, hard oil, or suction varnish is used on perfectly dry walls. Calcimine is said to give best results when applied to walls that have had a coat of flat or semigloss oil paint.

Before painting with oil paints plaster less than a year old and not previously coated with oil paint, it is best to apply a solution of zinc sulphate, ammonium carbonate, or carbonated water. Smooth hard-finish plaster should be coated with a good flat-finish varnish size. A little wall paint should be added if the paint and varnish will mix without livering. A coat of thick paint should be rubbed well into all fine cracks in the plaster and allowed to dry before the varnish sizing is applied. Varnish solutions for sizing walls are sold, but any good interior varnish that can be so thinned with turpentine or mineral spirits that it will dry flat will serve the purpose. Gloss oil and other cheap rosin varnishes, used under oil paints, may retard or prevent drying. Glue-and-oil size or glue size should be used on rough or sand-finish plaster.

Loose dust and dirt must be removed from plaster that has been coated with oil paint, and all defects in the surface remedied. The walls and ceilings in kitchens and bathrooms should be washed with soap and water and sponged off with clean water.

All gloss from enamel or ordinary house paints should be removed with sandpaper or steel wool.

METAL

Wire brushes, sandpaper, steel wool, scrapers, or a hammer and chisel may be used to remove rust and scale from metal surfaces. If metal roofing, guttering, or drain spouting is too badly rusted to be cleaned without making holes in it, the defective metal should be replaced. All rosin or other flux should be completely removed from the soldered seams of new metal. Deep rust spots on heavy metal not in contact with wood may be heated thoroughly with the flame of a blowtorch to remove all moisture. No loose paint or dirt should be left on the surfaces.

Some parts of implements and machines are usually coated with oil or grease, and new tinned and galvanized iron always has a thin film on the surface as a result of the manufacturing processes. All oil or grease should be removed with gasoline, mineral spirits, or other suitable solvent before the metal is painted.

Unless it has been exposed to the weather for a year or more, galvanized iron needs special treatment to roughen the surface slightly so that the paint will have a foothold. Strong vinegar or dilute hydrochloric (muriatic) acid, sometimes used to give such surfaces a "tooth," may attack the zinc coating too vigorously. A strong water solution of copper sulphate (bluestone), ammonium chloride (sal ammoniac), or ammonium phosphate is better than acid. Or a special undercoater, consisting of a thin, elastic flat varnish containing silica or siliceous material in suspension, may be applied to give the surface a "tooth."

HOW TO ESTIMATE THE QUANTITY OF PAINT NEEDED

To estimate the quantity of liquid coating needed, it is necessary to know the size of the surface to be covered and the spreading rate of the material to be applied.

SURFACE AREA OF BUILDINGS

The surface area is calculated in square feet from the dimensions in feet of the surface to be painted. Measurements which can not conveniently be made can usually be guessed with sufficient accuracy.

It is best to draw a diagram of each surface and mark on it the dimensions in the nearest number of feet. Such diagrams will usually be in the form of a parallelogram (a four-sided figure with opposite sides parallel), a trapezoid (a four-sided figure with only one pair of opposite sides parallel), or a triangle (a three-sided figure), or they may be divided into such figures. Calculate the area as follows, and add the results: *Parallelogram,* multiply the base by the altitude (perpendicular height); *trapezoid,* multiply half the sum of the two parallel sides by the perpendicular distance between them; *triangle,* multiply the base by half the altitude (perpendicular height).

SPREADING RATES

The following estimates for the quantity of coating materials needed for different surfaces are only approximate for average conditions. The figures for outside oil paints are based on 1 gallon having the consistency of ready-mixed paint or paint mixed for the finishing coat. This volume will, of course, be increased for priming and for second coats in three-coat work by adding linseed oil or a mixture of linseed oil and turpentine.

Coating material	Character of surface	Surface covered by 1 gallon		
		1 coat	2 coats	3 coats
		Sq. ft.	*Sq. ft.*	*Sq. ft.*
Oil paint (gloss finish)	Smooth wood	600	325	225
	Rough wood	350	200	135
	Metal	700	340	230
	Plaster	450	250	175
	Hard brick	400	225	160
	Soft brick	350	200	150
	Smooth cement	350	200	150
	Rough cement (stucco)	200	100	-------
Oil paint (flat finish)	Smooth wood or wallboard	500	275	200
	Plaster	400	225	160
	Hard brick	350	200	150
	Soft brick	300	175	125
	Smooth cement	300	175	125
	Rough cement (stucco)	150	75	-------
Enamel paint	Smooth, painted with undercoats	500	250	-------
Exterior spar varnish	Smooth wood	500	275	200
Interior finishing varnish	Smooth wood	450	250	175
Shellac	Smooth wood	600	300	-------
Shingle stain [1]	Rough wood	125	75	-------
Asphalt roof paint	Smooth	250	-------	-------
	Rough	150	-------	-------
Asphalt-asbestos liquid roof cement	Smooth	100	-------	-------
Cold-water paint (5 pounds powder)	Smooth	300	-------	-------
Calcimine (5 pounds powder)	Plaster	400	-------	-------
Whitewash (4 to 5 pounds hydrated lime)	Wood	250	-------	-------
	Brick	200	-------	-------
	Plaster	300	-------	-------

[1] 2½ gallons per 1,000 shingles when dipped two-thirds their length.

ESTIMATING REQUIREMENTS

Divide the number of square feet of surface by the spreading rate of the liquid for the kind of surface to be coated and the number of coats to be applied.

It is not necessary to make as careful estimates for ready-mixed paints as for paint mixed on the job. For a two-coat repainting job on a house of moderate size and in good condition, it is fairly safe to get as many gallons of paint as there are rooms in the house. For a three-coat job about half again as many gallons may be required.

Ready-mixed paints are just about right for the final coat. They need to be thinned for the first coat and usually in three-coat work for the second coat. Ordinarily for a three-coat job two-thirds pint of turpentine and 2⅔ pints of linseed oil for every gallon of paint bought will be enough. For a three-coat job on new resinous wood, like yellow pine or cypress, provide about 1½ pints of turpentine and 1 pint of linseed oil for every gallon of paint. For repainting surfaces in fair condition with two coats, about half a pint of turpentine and 1 pint of linseed oil for every gallon of paint will be needed.

When the paint is to be mixed on the job from paste pigments, linseed oil, turpentine, and drier, the approximate quantities needed for each gallon of paint will be in the following proportions:

All-lead paint (p. 14)

White-lead paste	pounds	14½
Raw linseed oil	pints	3½
Turpentine	pints	1¼
Japan drier	pint	⅙

1 pound of zinc paste to 2 pounds of lead paste (p. 14)

White lead in oil	pounds	8⅙
Zinc oxide in oil	pounds	4 1/12
Raw linseed oil	pints	3⅔
Turpentine	pint	1
Japan drier	pint	⅙

1 pound of zinc paste to 4 pounds of lead paste (p. 14)

White lead in oil	pounds	10
Zinc oxide in oil	pounds	2½
Raw linseed oil	pints	3¾
Turpentine	pint	1
Japan drier	pint	⅙

One hundred pounds of white-lead paste will make about 7 gallons of paint, which is the average quantity needed for a two-coat repainting job on a six or seven room house. Mixed in the same proportions, 50 pounds will make 3½ gallons; 25 pounds, 1¾ gallons; and 12½ pounds, seven-eighths gallon.

One hundred pounds of white-lead paste with 50 pounds of zinc-oxide paste will make about 12 gallons of paint, and with 25 pounds of zinc oxide, about 10 gallons of paint. Smaller quantities of pigments mixed in the same proportions will give corresponding quantities of paint.

For tinted paints a small quantity of tinting color ground in linseed oil will also be needed. For every hundred pounds of lead probably less than a pound of Prussian blue or lampblack would be required. From 1 to 2 pounds of raw umber, burnt umber, raw sienna, burnt sienna, chrome yellow, chrome green, Indian red, or Venetian red would be needed for light tints and possibly 5 pounds for darker tints. From 3 to 5 pounds of French ocher for light tints and from 10 to 15 pounds for darker tints may be required.

The approximate proportions of some of the more common pigments, in unreduced[7] paste form, to make various colors are as follows:

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[7] If reduced pigments are used, larger quantities will be required.

Blue (sky).—White lead, 100 pounds; Prussian blue, one-half pound.

Browns.—*Bismark brown*: Burnt sienna, 100 pounds; burnt umber, 25 pounds; white lead, 10 pounds; orange chrome yellow, 5 pounds. *Chocolate (dark)*: French ocher, 100 pounds; Indian red, 20 pounds; lampblack, 10 pounds. *Seal brown*: Burnt umber, 100 pounds; French ocher, 80 pounds; white lead, 25 pounds.

Brownstone.—White lead, 100 pounds; Venetian red, 7½ pounds; medium chrome yellow, 2½ pounds; lampblack, 1 pound.

Buff.—White lead, 100 pounds; French ocher, 10 pounds.

Clay.—White lead, 100 pounds; French ocher, 15 pounds; Venetian red, three-fourths pound; lampblack, 1 ounce.

Creams.—*Cream tint*: White lead, 100 pounds; French ocher, 1 pound; lemon chrome yellow, one-half pound. *Deep cream*: White lead, 100 pounds; raw sienna, 1 pound; French ocher, one-half pound.

Dove.—White lead, 100 pounds; Indian red, one-half pound; Prussian blue, 2 ounces; lampblack, 1 ounce.

Drabs.—*Olive drab*: White lead, 100 pounds; raw umber, 30 pounds; medium chrome green, 2½ pounds. *Warm drab*: White lead, 100 pounds; French ocher, 10 pounds; lampblack, 1 pound; Venetian red, one-half pound.

Ecru.—White lead, 100 pounds; French ocher, 2 pounds; burnt sienna, one-fourth pound; lampblack, 1 ounce.

Fawn.—White lead, 100 pounds; French ocher, 7½ pounds; burnt umber, 1½ pounds.

Grays.—*Ash gray*: White lead, 100 pounds; French ocher, 1 pound; lampblack, 2 ounces. *French gray*: White lead, 100 pounds; drop black, 1 pound; carmine lake, 1 ounce; Prussian blue, a trace. *Lavender gray*: White lead, 100 pounds; drop black, three-fourths pound; Indian red, one-fourth pound. *Pearl gray*: White lead, 100 pounds; drop black, three-fourths pound; Indian red, 1 ounce. *Silver gray:* White lead, 100 pounds; French ocher, 1 pound; lampblack, one-fourth pound. *Smoke gray:* White lead, 100 pounds; French ocher, 2½ pounds; lampblack, one-fourth pound.

Greens.—*Apple green:* White lead, 100 pounds; medium chrome green, 2½ pounds; medium chrome yellow, 2½ pounds; lampblack, 2 ounces. *Moss green:* White lead, 100 pounds; medium chrome green, 15 pounds; medium chrome yellow, 30 pounds; lampblack, 5 pounds. *Olive green*: White lead, 100 pounds; medium chrome yellow, 10 pounds; lampblack, 2 pounds; medium chrome green, 1 pound. *Sage green*: White lead, 100 pounds; medium chrome green, 5 pounds; raw umber, 5 pounds.

Ivory.—White lead, 100 pounds; raw sienna, one-fourth pound; lemon chrome yellow, 2 ounces.

Lead.—White lead, 100 pounds; lampblack, 2 pounds.

Lilac.—White lead, 100 pounds; Venetian red, one-half pound; lampblack, 2 ounces.

Reds.—*Brick red:* Venetian red, 100 pounds; yellow ocher, 80 pounds. *Indian red:* Indian red, straight. *Maroon:* Tuscan red, 100 pounds; lampblack, 2 pounds. *Tuscan red:* Tuscan red, straight.

Salmon.—White lead, 100 pounds; French ocher, 10 pounds; Venetian red, 5 pounds; medium chrome yellow, 2½ pounds.

Sandstone.—White lead, 100 pounds; medium chrome yellow, 3 pounds; burnt umber, 2½ pounds; Venetian red, 2 ounces.

Tan (light).—White lead, 100 pounds; French ocher, 5 pounds; raw sienna, 2 pounds; Venetian red, 2 ounces.

Terra cotta.—White lead, 100 pounds; burnt sienna, 20 pounds.

Yellows.—*Canary (pale):* White lead, 100 pounds; lemon chrome yellow, 1 pound; French ocher, one-half pound. *Colonial yellow:* White lead, 100 pounds; French ocher, 3 pounds; lemon chrome yellow, 2 pounds. *Straw:* White lead, 100 pounds; French ocher, 7½ pounds; medium chrome yellow, 3 pounds.

HOW TO PAINT

Paint must thoroughly wet the surface to which it is applied, and the combined thickness of all the coats should be just sufficient to hide the surface. In outside painting two or three thin coats are better than one thick coat.

The extent and character of the surface and the kind of coating material used will determine the best way of painting. The usual way is by brushing. Shingle stains are often applied by dipping. Spraying is sometimes satisfactory for coating large smooth surfaces with materials especially adapted for the purpose.

BRUSH PAINTING

BRUSHES

Good tools, as well as good paint, are essential for a good painting job. Only good brushes, of the right size and construction for the work in hand, should be bought. The horsehair and vegetable fiber sometimes found in cheap brushes are poor substitutes for the bristles in the more expensive brushes.

A 4-inch flat brush is generally used for applying oil paints to large surfaces, but 3½-inch brushes are probably better for beginners. The bristles in 4-inch flat brushes should not be more than 4¼ inches long, except for experienced painters. For trimming and small surfaces, a flat brush, 2 to 2½ inches wide, with bristles 3 to 3¼ inches long, is suitable. A flat or oval sash brush, 1 to 1½ inches wide, with bristles about 2 inches long, is also necessary. A special penciling brush, the smallest oval sash brush, or a round lettering brush is needed for penciling brickwork. For varnishing there should be a special varnish brush, which has never been dipped in paint. On moldings, pipes, railings, and other surfaces which are not flat, oval brushes will probably be better than flat brushes.

A painters' dusting brush is convenient for removing loose dirt and dust. Calcimine brushes, wall-stippling brushes, roof-painting brushes, whitewash brushes, soft brushes for fine varnish and enamel work, and other special brushes are also needed at times.

For painting rough surfaces, which are very hard on brushes, old stubby brushes can be used. For applying shingle stain a cheap brush is as good as an expensive one.

Paint should never be allowed to dry on a brush. Nor is it advisable to keep paint brushes in water. When outside painting stops for more than an hour, the brushes should be kept in raw linseed oil. When painting is again resumed, as much oil as possible should be scraped or wiped from the brushes, after which the remainder should be thoroughly mixed with the paint by repeatedly filling the brush and scraping it against the inner edge of the paint pot. Brushes that have been used in flat-finish paints and are to be used again soon for the same purpose should be kept in kerosene during the interval. Before being used again, most of the kerosene should be wiped from the brush, and that remaining should be thoroughly mixed with the paint.

During long intervals between painting jobs, even if it is for several years, the most satisfactory method for keeping paint brushes in good condition is to hang them in raw linseed oil, preferably in closed containers. Each brush should have a hole bored through the handle, so that it can be slipped over the lower end of a double wire hook of such length that the bristles will be completely covered by the oil. Placing brushes in linseed oil or other liquids without support bends the bristles out of shape. The fresh paint remaining in a brush when it is ready to be stored need not be removed before the brush is placed in raw oil. The pigment, loosened by the oil during storage, will gradually settle out. A skin will form on the surface, but the oil below will keep the bristles soft. Any skin clinging to the metal or wooden parts of the brush can be easily scraped off. Fresh paint can also be removed from a brush by washing it first in turpentine, kerosene, or mineral spirits and then with soap and water, after which the bristles should be dried thoroughly and covered with wrapping paper.

After use varnish brushes should always be thoroughly washed, preferably in turpentine, although benzol or coal-tar naphtha will do. Brushes that have been in shellac or other spirit varnish should be cleaned with denatured alcohol. During all interruptions in the work brushes should be kept either in turpentine or in the varnish, with the bristles completely covered by the liquid, and the container should be kept closed. Clean varnish brushes may either be wrapped in paper and laid away or they may be hung in raw linseed oil, not, however, in the container used for paint brushes. Varnish brushes that have been kept in oil must be washed free of the oil, preferably with turpentine, before being used.

It is best to clean roof brushes thoroughly and store them dry, with no weight resting on the bristles. Brushes that have been used with oil or asphalt paints can be cleaned with turpentine or gasoline. Those that have been used with coal-tar paints can be cleaned with benzol or solvent naphtha.

Whitewash and calcimine brushes should be washed thoroughly in water after each day's work and hung up to dry, with the bristles down. They should not be put in whitewash or cold-water paint until the lime has thoroughly slaked and the liquid has cooled. Soaking for an hour or two before use swells and tightens a dry whitewash brush which loses its bristles.

Oil paints and varnishes containing much linseed oil can not be successfully removed after they have dried on a brush. Certain treatments will soften the hardened material to some extent, but the bristles must be scraped to clean them thoroughly. Sometimes the bristles can be separated by soaking the brush in raw linseed oil for a day or two and then washing with hot turpentine. Soaking a brush for 12 to 24 hours in a warm solution containing a pound of sal soda in 3 pints of water frequently softens it so that it may be washed with soap and water. Some painters believe that a mixture of soda ash or sal soda with borax or trisodium phosphate is less harmful. Lye or caustic soda ruins the bristles.

APPLYING THE PAINT

Hold the brush lightly but firmly, with the narrow part of the handle between the thumb and first two fingers, much as a pencil is held in drawing lines with a rule, and use it in such a way that it wears down uniformly and keeps its original shape. Do not grip a brush by the stock, with some of the fingers extending over the bristles, and do not bear down too hard on it. Use a moderate, even pressure in spreading the paint and a light, even pressure in finishing. The muscles of the wrist, which do most of the work, can be relieved by using also the muscles of the arm and even those of the shoulder. While the brush is being drawn back and forth across the surface do not let the hand lead, but keep it directly over the brush. Lift the brush from the surface before starting a return stroke. Poking or jabbing the brush into corners or cracks ruins the bristles.

Do not dip the brush too deep into the paint. One-third the length of its bristles is far enough. After dipping, tap the brush gently against the edge of the paint pot or draw it lightly across the inner edge to remove the excess paint. Use all of each brushful before dipping again. In painting overhead carry less than the usual quantity of paint in the brush.

Wipe immediately, with a clean dry cloth, surfaces that have been accidentally soiled with paint.

In painting outside surfaces start at the top and move downward. It is customary to start at one side and work across to the other side, covering a convenient stretch on the way. Brush the paint out thoroughly to a thin, even coating. Brushing up and down as well as across insures thorough covering and reduces brush marks. After all the surface within arm's length has been covered, "lay off" by drawing the empty brush lightly and smoothly across the entire length of the freshly painted piece, from the edge of the unpainted surface toward that which has been finished. On wood use long sweeping strokes parallel to the grain. Allow the brush to follow the hand at an angle to the surface, raising it gradually upon reaching the surface previously laid off. On stopping work for the day, be sure that the painted surface is defined by a straight line, such as the lower edge of a weather board or course of shingles. The application of fresh paint over the edge of paint that has already set causes unsightly laps.

Shingle stains and whitewash do not require any particular skill or special care for application with brushes. Spattering should be avoided if possible, and the material should be kept stirred while in use. Very dry surfaces should be moistened before whitewashing. When cold-water paint is applied by a brush to continuous outside surfaces, such as plaster or cement, the same care is required as for interior calcimining (p.30).

As flat-finish paints set almost as soon as they are put on, interior painting must be done more carefully than outside painting. Spread the paint on the surface and lay off quickly, brushing as little as possible. Once set, do not touch it with the brush. Finish a small section with each brushful of paint and work in narrow stretches. Do not overlap an adjoining section. Join two adjacent sections with light finishing strokes, which should be curved or semicircular rather than straight back and forth and should extend barely over the edges of the section previously painted. If all the brushing is done when the paint is first applied and the painted surface is not disturbed, the paint will level itself and hide the brush marks. Paint walls from top to bottom, using curved up-and-down strokes rather than cross strokes. An entire wall or ceiling should be finished without interruption. It is better for two or more persons to work on one wall or ceiling, with the windows open, than for one person to work in an atmosphere saturated with the vapor of paint thinners, with the windows shut. Because of the rapid evaporation of vehicle and thinner, paint pots should be only partly filled when using flat-finish paints and the bulk of the paint should be kept in closed containers.

To produce a stippled finish, apply a flat wall paint somewhat thicker than that ordinarily used, and dab the surface before the paint sets with a stiff dry brush held at right angles. A regular stippling brush is best.

To produce a mottled finish, apply wall paint over a ground color of another shade, and while it is still wet touch the surface lightly with crinkled wrapping paper loosely held.

To produce a blended finish, apply two or three coats of wall paint of ground color, stippling the last coat with a ball of cheesecloth. When the surface is dry apply a glazing or lake color harmonizing or contrasting with the ground color, thinned with linseed oil or turpentine and a little drier. While the surface is still wet, wipe away the last coat in spots with a cloth, so that the ground color shows through more in some places than in others. When two or more glazing colors are desired, each color is applied in irregular patches with a separate brush, and the edges of each patch are dabbed with a ball of cheesecloth, after which the entire surface is stippled with a brush.

CALCIMINING

Use special calcimining brushes. Spread the material, which should be as thick as possible without leaving brush marks when applied, thickly and evenly over the surface with the least possible brushing. The object is to hide the surface with one coat; an attempt to apply a second coat may remove the first. If a second coat is necessary, as it may be on very smooth plaster, it should be thin, and the surface should be brushed over very lightly and carefully with a solution of alum just before it is applied.

Have the room as light as possible and cover the surface completely and uniformly. Work in narrow stretches across spaces in the shortest direction. Always start in a corner and work away from the light. To keep laps from showing, the edge of one stretch must not be dry when being joined with the next. Drafts and warm ceilings and walls make coatings dry too quickly. If the edge of a stretch dries, apply plain water with a clean brush lightly and carefully before joining it with the next stretch. In joining do not apply more pigment to the lap than elsewhere, but work the paint of one stretch into the edge of the preceding one by gentle brushing. After the coating is on give all the ventilation possible; if the air is full of moisture, heat the room. Slow drying may cause a spotted appearance.

VARNISHING AND ENAMELING

Do not brush out varnish and enamel thoroughly like ordinary house paints, but flow them on to the surface by means of special varnishing and enameling brushes held obliquely, with just enough light brushing to even them and spread out the excess to prevent sags or runs. Varnishes and enamels, designed to be self leveling, soon become tacky with continued brushing.

Before varnishing, sandpaper the surface perfectly smooth. Unless a natural finish is desired, first apply an oil, water, or spirit stain to new wood and treat open-grain woods, such as oak, chestnut, ash, elm, walnut, and mahogany, with a paste wood filler according to the directions on the cans. The filler can be colored to match the stained wood, although this may not be necessary as the filler is usually transparent under varnish. Sometimes a light filler is used on a dark wood for a special effect. After the filler has dried smooth the surface with sandpaper. Several coats of varnish may be necessary. Before applying a new coat, remove the gloss from the previous one after it has become dry and hard, by rubbing it with very fine steel wool, curled horsehair, or wet felt dipped in powdered pumice stone. If pumice stone is used, keep the surface wet. Do not allow any pumice to dry on the varnished surface, but sponge it off immediately with clean water and dry the surface with chamois skin or a clean cloth.

A rubbed or satin finish having a dull luster is sometimes given to the last coat of varnish by rubbing either with powdered pumice and water as described or with powdered pumice alone, using a block covered with thick felt saturated with mineral oil. A high polish or piano finish can be produced on certain varnishes that have become thoroughly dry and hard by using pumice stone, followed by polishing with oiled felt and rottenstone, using the palm of the hand for the final rubbing.

Enamel should not be applied until the surface has been given two or more coats of flat-finish paint of the same color. Special undercoating paints may be used with enamels, but ordinary paint is satisfactory if most of the linseed oil in it is poured off when the pigment is well settled, and enough turpentine or mineral spirits, containing some extra drier, is added to give a flat finish. Before the enamel is applied, the surface should be smoothed with fine sandpaper.

If the surface has been enameled before, remove the gloss of the old coat, by rubbing with curled horsehair, fine sandpaper, or steel wool.

To give the surface a satin finish, use special varnishes and enamels which dry with a subdued luster.

To give a stained and varnished appearance to painted wood, treat the surface with a crack and crevice filler, unless it is perfectly smooth and free from cracks. Then paint with a ground color for graining (flat-finish cream) and let it dry thoroughly. Next sandpaper the surface and grain it with distemper paint, using rubber graining tools. Each board or other well-defined surface should be grained separately. After the grain color has dried apply a varnish stain.

SPRAY PAINTING

Special spraying devices are used extensively for applying water paints to large interior surfaces and in factories for finishing automobiles, furniture, hardware, and machinery. The results first obtained with exterior spray painting did not compare very favorably with those obtained with brush painting, but as the machines have been improved and more experience gained spray painting has become more satisfactory. A good operator can cover a surface adapted to spray painting as well by using a good machine as by hand brushing and in much less time. This method is particularly good for large surfaces with few openings and little or no trimming. As spray painting outfits are expensive and experience and practice are necessary for their successful operation, this method will be used almost entirely by painting contractors and others who have a great deal of painting to do. With an air brush or paint gun the space is covered so quickly that it must be done right the first time. Any attempt at improvement by going over the same surface a number of times results in too much paint.

The only kind of spray painting that does not require the services of an expert is whitewashing. When properly thinned and strained whitewash can be applied with a bucket or barrel-spraying outfit, such as is used for spraying fruit trees. The nozzle for Bordeaux mixture is suitable for whitewash. Application of whitewash with a high-pressure spray pump is better than brushing because it insures penetration of cracks and crevices.

DIPPING

Dipping is another labor-saving method of paint application confined chiefly to factory practice. Articles varying in size from toys to parts of large machines are coated in this way. When the paint is especially well adapted to the purpose and the drying conditions are properly controlled, the coating is continuous, uniform, and durable.

The only other common use of the dipping method is in painting or staining shingles. Shingles should be dipped to cover about two-thirds their length and should be kept in the material long enough to thoroughly color the surface. They should then be set in a trough, tipped to permit the excess of liquid to drain back into the dipping vessel. Shingles that have been dipped in paint should be brushed lightly on both sides to remove the excess.

PRECAUTIONS

Do not use white-lead paints in places where they will come in contact with drinking water, silage, or food products.

Do not inhale the dust when scraping or sandpapering surfaces coated with lead paints. If dust can not be avoided, cover the mouth and nose with loose cotton inclosed in several thicknesses of cheesecloth or with a respirator or mask. Keep the skin as free as possible from paint and thoroughly clean the hands before eating, using oil or grease to remove most of the paint, followed by soap and water. Handling food with hands that are covered with lead paint is dangerous.

When painting or varnishing indoors keep the windows opened enough to permit free circulation of air.

Keep paints, varnishes, oils, and thinners away from heat and flames; they are inflammable.

Dispose of all rags or waste containing paint, varnish, or oil in such a way as to avoid the possibility of fire from spontaneous combustion.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

March 31, 1925

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1453

GROWING & PLANTING CONIFEROUS TREES ON THE FARM

CONIFEROUS TREES are especially well adapted for planting on the poor waste areas common to many farms. They grow fairly rapidly and yield heavy crops of timber. They are very effective as windbreaks. Even in small sizes they may in some localities be disposed of at a profit as Christmas trees and in large sizes they have an assured market for lumber or pulp wood.

This bulletin points out simple methods of collecting the seed, growing the trees in a small home nursery, planting them out in the waste places on the farm, and giving them the small amount of care subsequently desirable.

Washington, D. C. Issued July, 1925

GROWING AND PLANTING CONIFEROUS TREES ON THE FARM

By C. R. Tillotson,
Forest Inspector, Branch of Forest Management, Forest Service

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CONIFEROUS TREES (pines, spruces, firs, and the like) suitable for forest planting can not be grown from seed, as a rule, in less than two to four years; shortleaf pine, loblolly pine, and slash pine are often large enough in one year. If produced in a small nursery on the farm, a corresponding delay will ensue before the trees can be planted in the field. This may be an objection. To the majority of farmers who want to set out a few hundred or thousand such trees, therefore, the general advice of the Forest Service is to secure them from the State-operated nursery, if there is one (see Appendix, p. 37), or from a reliable commercial nursery.

It sometimes happens, however, that the kinds of trees desired can not be procured from either of these sources or the prices may be very high. Trees procured from nurseries, moreover, are not always in the best condition when received, especially if poorly packed or if shipped a considerable distance. Further, there are some distinct advantages in having home-grown trees: They will be on hand when wanted for planting in the field and will be in good condition. If for these or any other considerations a farmer desires to grow his own trees in a small home nursery, there is no good reason why he can not do so. It will require some time, attention, and labor, but the difficulties are not great.

There are two main steps in the nursery operation: (1) Procuring the seed, and (2) growing the trees in the nursery. Two other operations follow: (1) Planting the trees in the field, and (2) caring for the plantation. To assist those wishing to grow and plant a few conifers this bulletin discusses simple methods. Before embarking on the operation, however, the first thing is to decide upon the kind of tree that will suit the planter.

NOTE.—Acknowledgment is made to the State foresters of New York, New Hampshire, Vermont, Massachusetts, Pennsylvania, Virginia, Ohio, and Michigan for material that was of great assistance in the preparation of this bulletin.

WHY GROW CONIFERS

There are several reasons why it is desirable to grow conifers (pine, spruce, fir, etc.) rather than hardwoods (elm, ash, oak, walnut, cottonwood, etc.). Probably the most important is that some species of conifers, the pines in particular, will ordinarily take hold and thrive better than hardwoods on poor soils, such as worn-out fields or pastures, sandy areas, cut-over and burned-over woodlands not restocking naturally, and areas with shallow soil. (Figs. 1, 2, and 3.) This is especially true when cultivation is not given the trees after they are set out. It should not be concluded that conifers grow best under such adverse conditions. Like any other soil crop, trees grow most thriftily on rich, deep, well-drained soils. While pines may live under conditions where other species are almost bound to fail, their rate of growth will often be slow, sometimes disappointingly so.

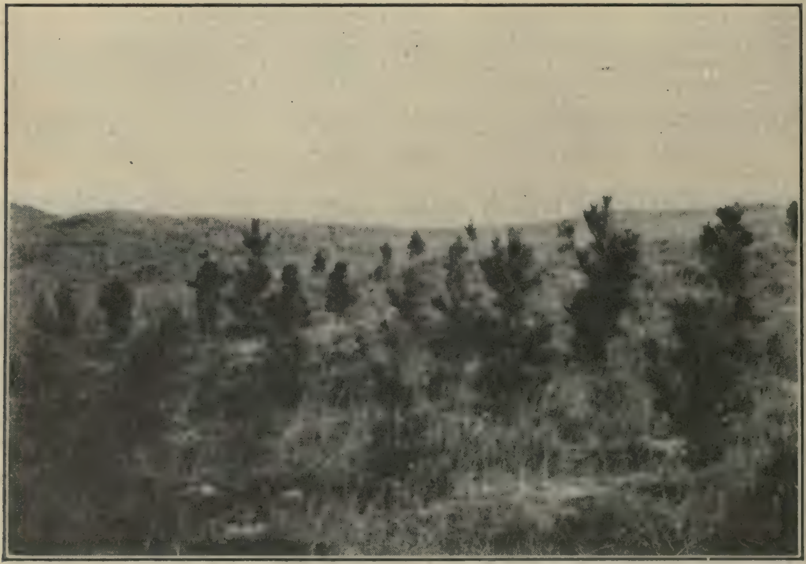
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Fig. 1.—Ten-year-old western yellow pine plantation in the sand hills of Thomas County, Nebr.

With the possible exception of two or three species of hardwoods, nearly double the yield of saw-log material can be procured from a fully stocked merchantable stand of conifers than from a similar stand of equal-aged hardwoods. More coniferous trees can be matured to the acre and their upright unbranched trunks make it possible to saw three to five 12-foot logs from each tree in a 50 or 60 year old stand, while two or two and one-half logs is more nearly the average for hardwoods of the same age. Where a large yield of timber is the primary object, therefore, conifers are generally preferable to hardwoods.

There are other reasons for giving preference to conifers: they are ornamental in winter as well as in summer; and as windbreaks they are much more effective the year round than hardwoods.

CHOICE OF TREES

The trees chosen should be determined by the object of planting, by their adaptability to the climate and soil of the region, and by their resistance to serious diseases or to insect attack. It would be foolish, for instance, to grow for saw timber Virginia pine (often also called scrub pine and spruce pine) in those parts of Maryland where shortleaf and loblolly pines, both much more valuable commercial species, can be grown just as easily. No attempt should be made to grow southern longleaf and slash pines in the Northern States, since they would be killed by the severe winters. It would generally be inadvisable to grow spruce or fir on poor, sandy lands where the climate is suitable for pines. The latter will develop much better on these soils. If he expects to grow white pine a prospective planter should realize the danger from white pine blister rust and be prepared to take the measures necessary to combat it.

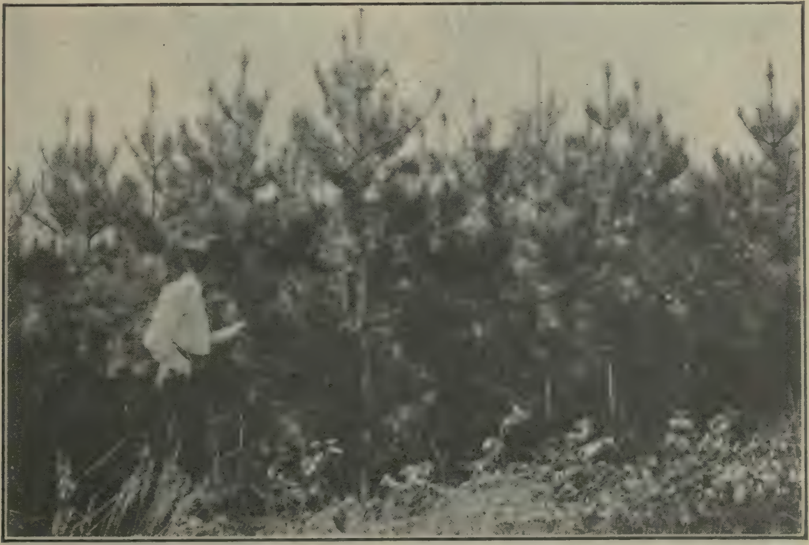

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FIG. 2.—Ten-year-old red pine plantation in Itasca County, Minn. Red pine is one of the best species for that region

The eastern red cedar should not be planted anywhere near apple orchards because the disease known as cedar rust spreads from this tree to the leaves and fruit of apple trees.

The map (fig. 4) indicates some of the conifers which seem adapted for planting in the districts outlined. This does not mean that all the species listed in any one district can be grown in all parts of it or under all conditions of soil existing there; neither does it mean that other trees may not be suitable. In Nebraska for instance, Jack pine is adapted only to sandy soils in the western part of the State and even there may be killed by droughts of long duration. For climatic reasons, the Pacific coast form of Douglas fir is not suited for planting in eastern Oregon and Washington; it is necessary to procure Douglas fir trees that have been grown from seed collected east of the Cascade Mountains. There is yet much to be learned about these matters through experience. *In choosing the tree or trees, the safest rule is to select those which occur naturally on a similar situation in the region or have been grown there successfully.* If there is no such guide, it is best to write the State forestry department and secure advice in the matter. (See list of State forestry departments in the Appendix, p. 37.)

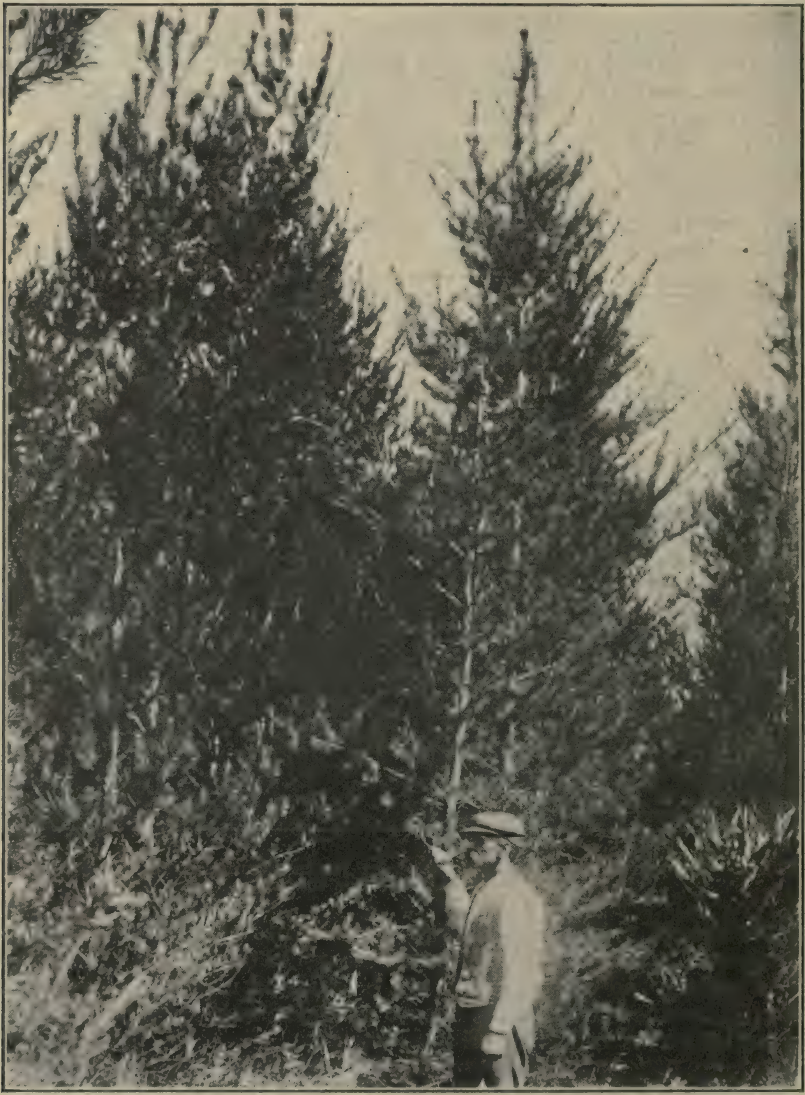

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FIG. 3.—Fourteen-year-old jack pine plantation in sand hills of Holt County, Nebr. Trees are 12 to 24 feet high

RATES OF GROWTH

Information concerning the rates of growth of coniferous trees is available for some species and may be of help in determining the choice of those to be planted. Rough figures for trees in the forest are given in Table 1. These figures are not equally applicable over the wide range of territory in which a given species can be

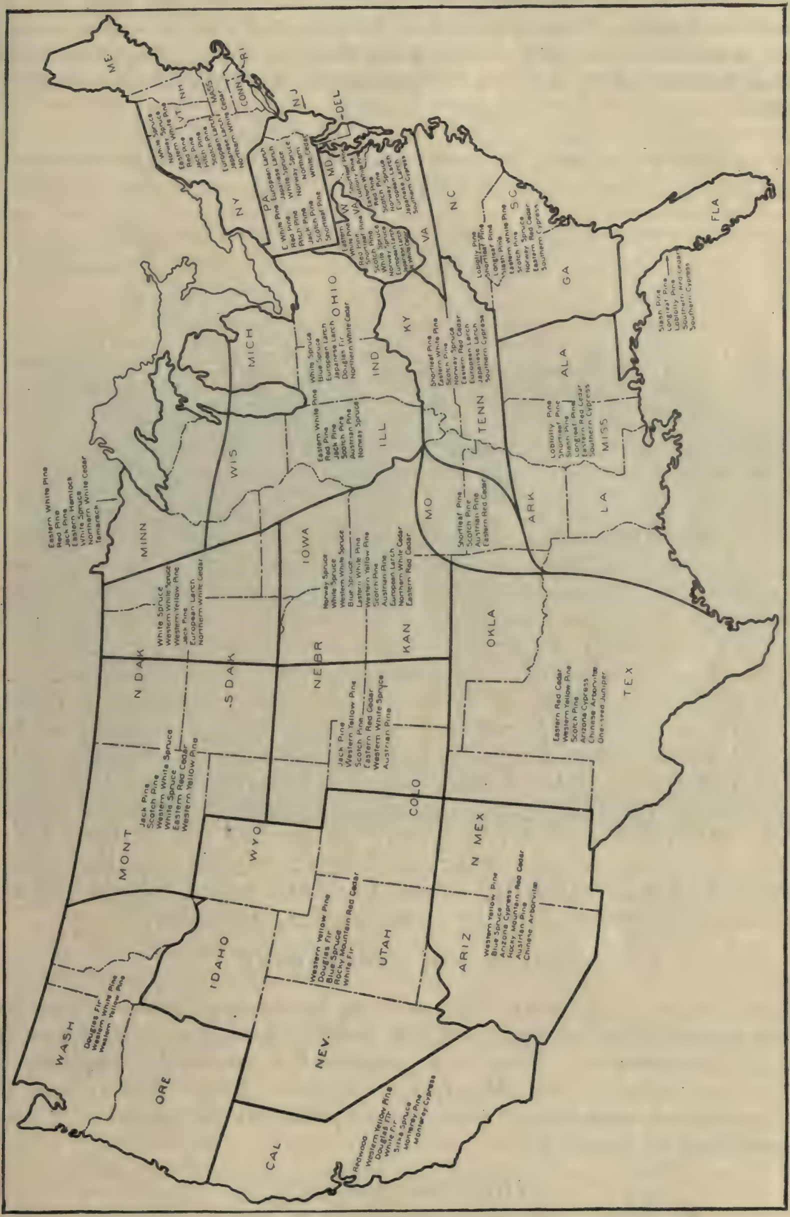

FIG. 4.—Some coniferous trees suitable for planting on farms, by regions

grown and under the great variety of climatic and soil conditions encountered. For comparative purposes, however, they will serve fairly well. Growth appears very slow for some species. Trees will commonly make more rapid growth in a plantation than in a natural forest, because they are usually less crowded and are not shaded in youth. Trees planted in windbreaks two or three rows in width make considerably faster growth than those planted in solid blocks, because they have an abundance of sunlight and growing space.

TABLE 1.—*Number of years it takes trees in forest stands to grow 1 inch in diameter*

Years	Species	Years	Species
2 to 3	Redwood.	4 to 8	White spruce.
3 to 4	Douglas fir (of the Pacific coast).	4 to 15	Eastern red cedar.
3 to 5	Southern cypress, loblolly pine, shortleaf pine, slash pine.	5 to 6	Norway spruce.
3 to 7	European larch.	5 to 7	Sugar pine, western white pine.
4 to 6	Scotch pine, Virginia (scrub or spruce) pine, Sitka spruce.	5 to 12	Western yellow pine, hemlock.
4 to 7	Jack pine, longleaf pine, red pine, eastern white pine.	6 to 8	Red spruce.[1]
		7 to 12	Balsam fir, incense cedar.
		8 to 15	Douglas fir (of the Rocky Mountains), lodgepole pine.

[1] Old pasture stands.

PROBABLE YIELDS

Not many figures are available concerning yields from plantations. A study[1] of older plantations in Massachusetts a number of years ago revealed that some of these had made very good growth (fig. 5). Yields per acre of 17,000 board feet in 36 years, 24,000 feet in 39 years, 33,000 feet in 43 years, 32,000 feet in 46 years, 35,000 feet in 50 years, 44,000 feet in 55 years, 38,000 feet in 56 years, and 44,000 feet in 60 years are recorded in eastern white-pine plantations. A mixed 48-year-old plantation of eastern white pine and Norway spruce contained 33,000 board feet per acre (fig. 6).

A few species, such as redwood and Douglas fir of the Pacific coast, should yield more than white pine under average conditions. Others will yield less. Given good care on fair soil in their native region, the more valuable species of conifers grown in the plantations on farms should yield 10,000 to 25,000 board feet to the acre at an age of 50 years; in many cases, a great deal more.

TREES FOR WINDBREAKS

Trees which have dense foliage that is retained over winter and whose lower branches hang on for a long period of years are the best for windbreaks. These are spruces, firs, hemlocks, Douglas fir, arborvitæs, cedars, and Monterey cypress. The white pines are nearly as good, and Scotch pine is very effective up to 12 or 15 years of age (figs. 7, 8, and 9).

PLANTING EXOTICS

By exotics is meant trees which are not native to a region. This may include trees not only from Europe, Asia, or other foreign countries, but from distant parts of the United States. For instance, Douglas fir, which is native to the Rocky Mountains and Pacific coast regions, is just as much of an exotic to the eastern United States as is Scotch pine, which is native to Europe. Ordinarily the planting of exotics in large numbers is inadvisable unless vigorous-growing trees in the immediate region prove that the species will succeed. Catalogues, the word of interested agents, advertisements, or newspaper articles are not sufficient evidence of the worth of such trees. Extensive planting of untried exotics is more than likely to lead to loss of trees, time, and money, and to consequent disappointment. It is a safer plan to use those native species which are so good that they have made their own reputation and do not need to be advertised. A few European conifers widely introduced into the eastern part of the United States have done very well. The most common of these are Scotch (fig. 10) and Austrian pines, Norway spruce, and European larch (fig. 11). Japanese larch, Japanese red pine, and Japanese black pine are promising species for some localities. It has not yet been demonstrated, however, that these are generally superior to, even if they are as good as, some of the native trees. Scotch pine has shown great ability to grow well during youth upon some of the poorest bare, sandy soils, blow sand in particular, in the eastern United States. (Fig. 10.) Norway spruce (fig. 6) grows more rapidly than our native eastern spruces, at least up to 50 or 60 years of age.

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[1] J. R. Simmons, The Older Forest Plantations in Massachusetts—Conifers.

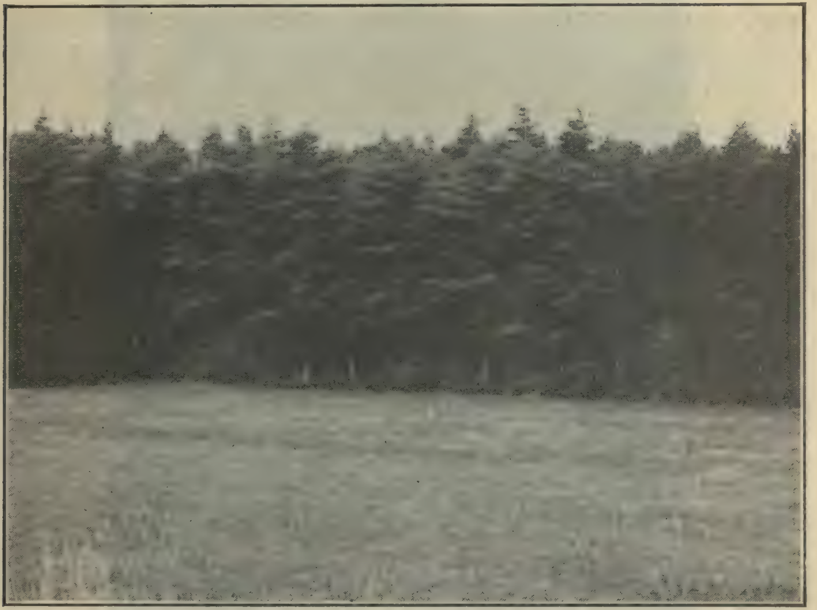

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FIG. 5.—Plantation of white pine at East Bridgewater, Mass., started in 1875 with trees taken from a pasture. It was cut 47 years later, and yielded 33,000 board feet to the acre

PLANTING TWO OR MORE KINDS OF TREES IN MIXTURE

There is not enough known in regard to planting our native trees in mixture to justify recommendations. A few young plantations indicate that red pine and eastern white pine or Norway spruce and eastern white pine may safely be planted in mixture. European larch in combination with eastern white pine or Norway spruce also appears to be a good mixture. In such a combination, about one-third of the trees should be larch and two-thirds pine or spruce. Doubtless other combinations will succeed, but mature plantations in this country which prove what species may successfully be mixed in plantations are unknown to the writer.

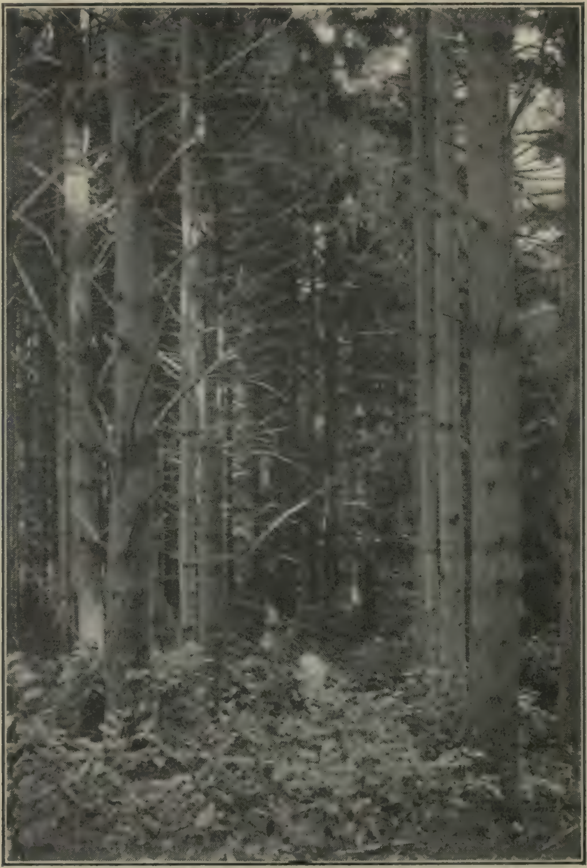
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FIG. 6.—Forty-eight-year-old Norway spruce and white pine plantation near Georgetown, Mass., which if cut would yield 33,000 board feet to the acre

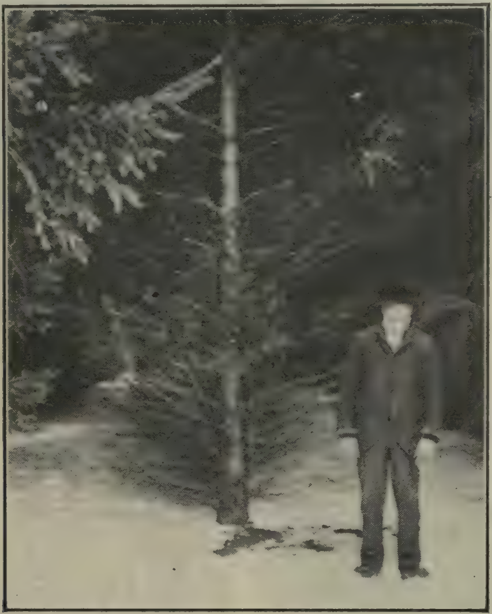
A row of northern white cedar (arborvitæ) backed up by a row or two of spruce or pine is a very effective combination for a windbreak.

UNDERPLANTING OLD STANDS OF TREES

If an owner wishes to plant under scattered old limby trees, the best conifers for the purpose are firs, hemlocks, and spruces. Even these species will not grow rapidly if planted in deep shade. Such underplanting is not recommended, therefore, unless the trees are set in openings where they will not be shaded much or unless the old trees are to be removed within three to five years.

PROCURING THE SEED

Seed can be collected from trees in the locality or purchased. When inexperienced labor is employed to collect and extract seed, it is likely to cost as much or more than if purchased from a seed dealer. Even so, there will be the certainty of its being fresh and of local origin.



F-16217

FIG. 7.—Interior of a Norway spruce windbreak on an Iowa farm which affords almost perfect protection against wind

Before procuring seed from any source, something should be known about the yield of clean seed from a bushel of cones and the approximate number that will sprout in a pound. (Table 2.)

This information is not available for all species, and the figures given should not be taken as absolute, since they are subject to considerable variation.

COLLECTING THE SEED

The seed of coniferous trees is inclosed in the cones or "burs" (figs. 12 and 13), which are borne for the most part toward the tips of the branches or, in the case of the spruces, mainly near the very

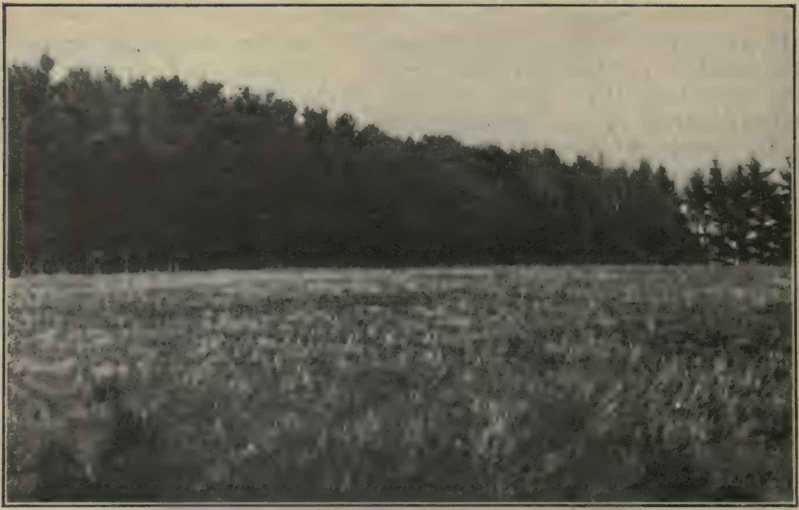


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FIG. 8.—Forty-year-old windbreak of white pine and northern white cedar in Fayette County, Iowa, 55 feet high. This is a splendid combination for a windbreak

tops of the trees. To obtain the seed, it is necessary to collect the cones before they become so ripe on the tree that the scales open and permit the seed to fall out. In the case of the true firs, the cones actually fall to pieces on the trees when they become thoroughly ripe.

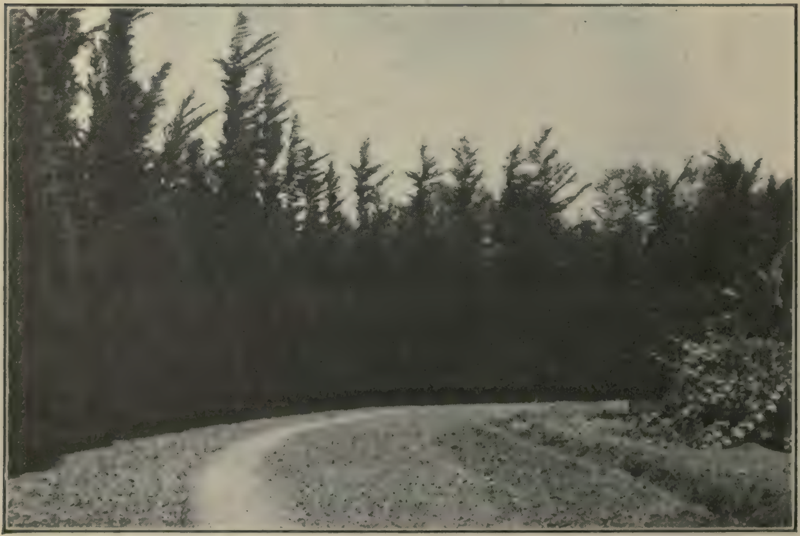

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FIG. 9.—Monterey cypress windbreak. San Diego County, Calif.

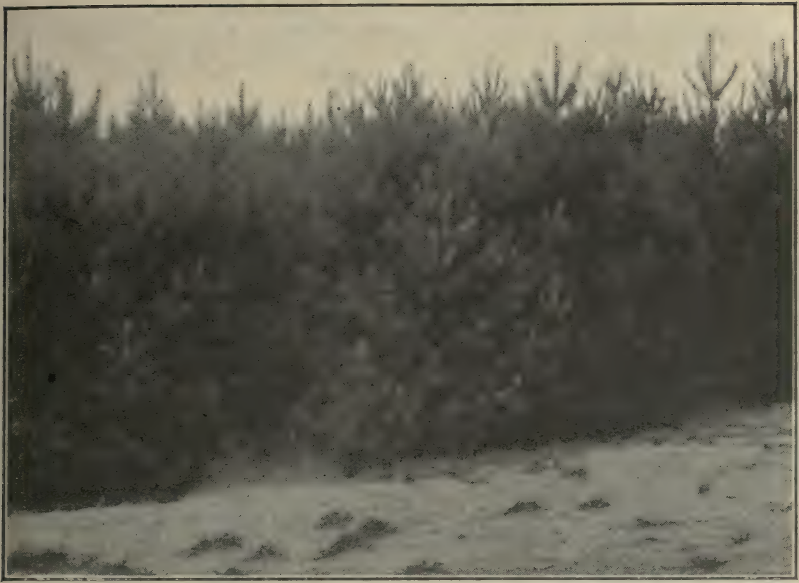

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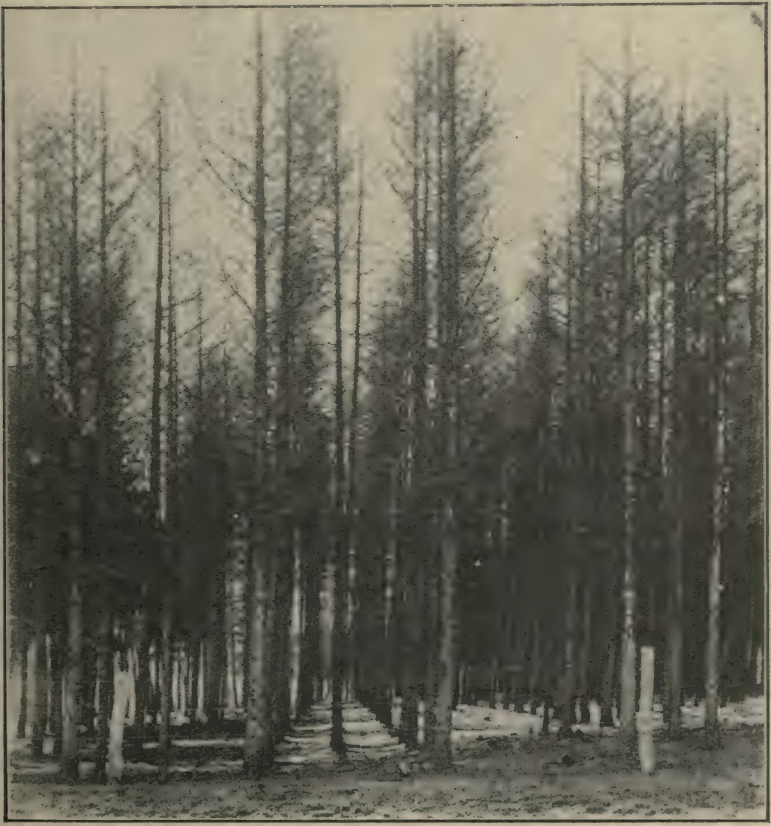
FIG. 10.—Young plantation of Scotch pine on a hill of bare, shifting sand. Trees are making a height growth of 2 feet or more a year. Lyndon, Vt.



F-19062

FIG. 11.—Twenty-seven-year-old European larch plantation in Kane County, Ill.

TABLE 2.—*Information about forest tree seed*

Species	Pounds of seed per bushel of cones	Number of seed per pound	Number of seedlings 1 pound of seed will produce	Ounces of fresh seed to sow per 100 square feet of seed bed to produce 100 seedlings per square foot
Northern white cedar		280, 000	12, 000–30, 000	5–13
Chinese arborvitæ		25, 000		
Western red cedar	1. 5	400, 000	26, 000	6
Incense cedar	2. 5–3	17, 000		
Eastern red cedar	. 75	17, 000	6, 000	
Southern white cedar		470, 000		
Arizona cypress		100, 000		
Southern cypress		7, 500		
Monterey cypress		58, 000		
Douglas fir	. 4–1. 25	45, 000	16, 000–20, 000	8–10
Balsam fir		35, 000	5, 000	32
Noble fir	2. 5	17, 000	1, 500–2, 500	64–106
White fir	3	12, 000		
Eastern hemlock		300, 000	4, 000–6, 000	27–40
European larch		60, 000	5, 000–10, 000	16–32
Japanese larch		110, 000	7, 000–16, 000	10–23
Western larch	. 5–0. 9	150, 000	15, 000	11
Austrian pine		24, 000	7, 000–10, 000	16–23
Jack pine	. 5	150, 000	15, 000–35, 000	5–10
Japanese black pine		48, 000	24, 000	6⅔
Japanese red pine		52, 000	35, 000	5
Loblolly pine		20, 000		
Lodgepole pine	. 35–1	80, 000		
Longleaf pine	1	6, 000		
Monterey pine		20, 000		
Pitch pine		55, 000	11, 000	15
Red pine	. 5–1	54, 000	20, 000–35, 000	5–8
Scotch pine		70, 000	8, 000–14, 000	12–20
Virginia pine		60, 000		
Shortleaf pine		45, 000	22, 000	8
Slash pine		18, 000		
Sugar pine	1. 6	2, 400		
Western white pine	. 3– . 75	28, 000	8, 000	20
Eastern white pine	. 7–1	26, 000	8, 000–14, 000	12–20
Western yellow pine	. 7–2	9, 000–16, 000	2, 500–5, 000	32–64
Redwood		160, 000		
Blue spruce	1	80, 000–130, 000		
Engelmann spruce	. 5–1	175, 000	15, 000–40, 000	4–11
Norway spruce		60, 000	14, 000–35, 000	5–12
Red spruce		130, 000	16, 000–25, 000	7–10
Sitka spruce	1. 25	100, 000	30, 000–40, 000	4–6
White spruce	. 5	180, 000	14, 000–20, 000	8–12

NOTE.—The figures in the above table are not absolute; they may vary more than table indicates.

WHEN TO COLLECT

No definite time can be set for the collection of cones. Although they sometimes begin to ripen the latter part of August, even in mid-October they may not be too far opened for collecting from the trees. Some of the cones of certain pines remain closed for years and may be collected at any time while in that condition. On the other hand, it is useless to collect after the cone scales have opened widely, because the greater part of the seed will have fallen out. One of the safest ways to judge whether cones are ripe is afforded by the actions of squirrels. Coniferous-tree seed is a favorite winter food of squirrels. When the seed is ripe, these animals cut the cones from the trees and store them away. It is safe, therefore, to commence collecting as soon as the squirrels do so.

Another test of ripeness is to cut into a cone and examine the seed. If the kernel is full, plump, and white, but not milky, the seed is ripe. Often the cones will still be greenish in color, or just starting to turn purple or light brown when the seed is fully mature.

WHERE TO COLLECT

Fresh seed from local sources is generally considered preferable, since trees grown from it are almost certain to be hardy. Cones should be collected from newly felled or standing, vigorous, healthy, middle-aged trees; seed from runty or diseased specimens, overaged, or very young trees is likely to be no good. Although trees growing in the open usually produce cones in greater quantities than those in dense stands, those newly felled in logging operations are one of the most prolific and best sources of cones.

HOW TO COLLECT

Cones can be readily picked by hand from felled trees. It is not so easy to pick them from standing trees. Some people climb the trees in order to reach the cones (fig. 14); others use ladders. Sometimes branches laden with cones are cut off and thrown to the ground, where the cones can be picked without difficulty. This practice disfigures the trees and greatly reduces their future cone-bearing ability, and should not be followed if it can be avoided. Long-handled tree-pruning shears or sharp hooks can sometimes be used to advantage in cutting the cones from the trees. Collecting is often a very sticky, disagreeable task because of the resin on cones, leaves, and twigs. The collector needs a bottle of kerosene which can be used frequently to cleanse the hands.

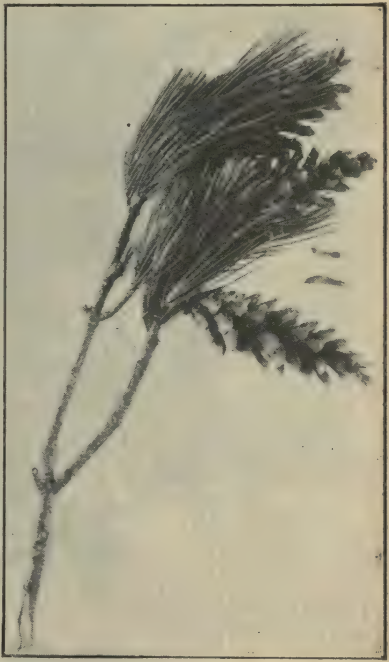


FIG 12.—A white pine branch showing opened cones from which the seed has fallen. Two seeds with the wings attached are shown to the right

Squirrels store cones around old rotten logs, among the roots of trees, along streams, beneath overhanging stream banks, and in similar situations. (Fig. 15.) One or two bushels are commonly stored in one place, and hoards up to 40 bushels have been found. One or two bushels of cones is ordinarily a good day's collection from standing trees; from squirrel hoards it is often possible to collect several times this quantity. Another advantage of collecting from squirrel hoards is that the cones remain damp and closed and can be gathered after those attached to the trees have opened.

CARE OF CONES

Fresh unopened cones are somewhat moist. If closely packed together for some time they are likely to heat and mold, with consequent damage to the seed. To avoid this the seed should be extracted within a few days or the cones spread out to dry three or four deep in well-ventilated bins or boxes. This is an important precaution.

EXTRACTING THE SEED[2]

OPENING CONES BY SUN HEAT

A practicable method of extracting seed for the man who has collected a relatively small quantity of cones consists in spreading the cones out thinly on cloth or on a flat roof and exposing them to the sun's heat until the cone scales open and spread out. This may take several days even in fair weather, and still longer in weather which is intermittently rainy and bright. The drying will be hastened if the cloth is spread on a platform of boards rather than on

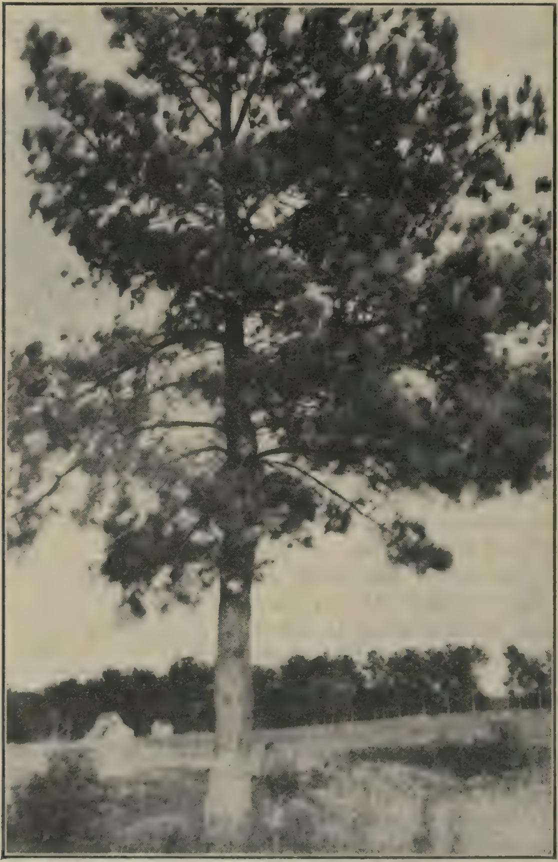


FIG. 13.—A loblolly pine bearing a crop of cones or "burs." The seed is found within the cones

the moist ground and if the cones are occasionally turned over so as to expose all surfaces to the sun's rays. (Fig. 16.) Lodgepole and jack pine cones, as well as some others, can not be opened this way; they need the application of artificial heat. The cones should be covered each night to protect them from rats, mice, or other night-prowling rodents.

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[2] For more complete discussion, see Forest Service Circular 208, Extracting and Cleaning Forest Tree Seed. Available by purchase from Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents.

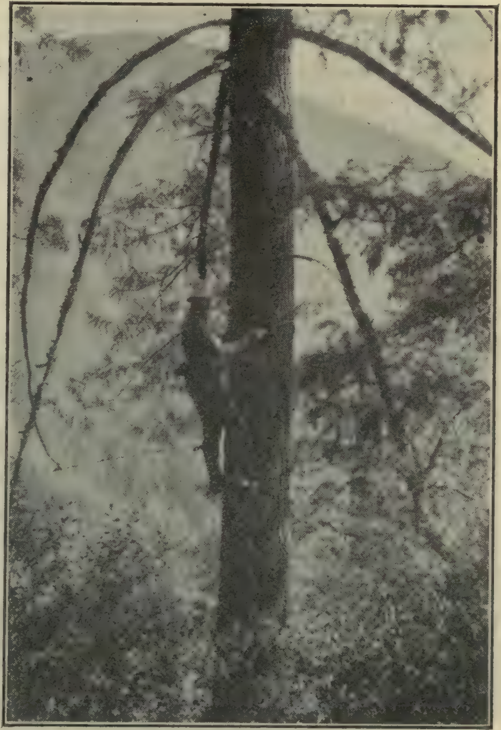
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FIG. 14.—Climbing tree to collect cones. Although this is slow and laborious, sometimes it is the only way by which cones can be obtained

OPENING CONES WITHOUT HEAT

Some kinds of cones will open at the ordinary temperatures if given time enough. They can be spread out two or three deep on the floor of a shed or granary and left until they open. They open somewhat more rapidly if raked over each day. In such places, however, many of the seed are likely to be eaten by mice or other rodents.

If there is only a small quantity of cones to deal with they can be placed in boxes or baskets and set in the kitchen back of the stove. The heat from the stove will hasten their opening considerably.

OPENING CONES BY ARTIFICIAL HEAT

This method involves considerable preparation and special equipment, and will be touched upon only briefly.[3] To dry cones by artificial heat, a shelter such as a tight-walled building, room, or tent is commonly employed. A tight shed will do. A stove, furnace, or steam pipes can be used to heat it to a temperature of 110° to 150° F. Stoves are not very satisfactory, because they do not distribute heat constantly and evenly, and tents are not tight enough to retain the heat well. Trays which will hold one-half to 1 bushel of closed cones are ordinarily provided, and racks on which to place them are built in the shelter. The bottoms of the trays should be slatted or constructed of wire netting, so that the air can circulate freely and the seed can fall through to the floor. Ventilation must be provided, in order that the moisture driven from the cones as they are heated will escape from the shelter and be replaced by dry air from the outside. By gradually shifting the trays from the racks at low levels, where the heat is less intense, to those at higher levels, where the heat is greater, cones can be opened in 10 to 15 hours (fig. 17). Opening is hastened if the cones are stirred frequently. Shelters used for seed extraction become very dry and inflammable and frequently catch fire. Adequate precautions must accordingly be taken against fire during the extraction process.

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[3] See footnote 2.

SHAKING OUT THE SEED

During the drying process a portion of the seed will fall out of the cones. A great many will stick to the cone scales, however, and will have to be loosened by shaking or jarring. Vigorous raking of the cones after they are well opened will sometimes dislodge a fair proportion of seed. A greater proportion can usually be obtained by shaking the opened cones vigorously for a period of 5 to 10 minutes in a shaking device. A simple piece of equipment is a box or tray, the bottom of which is constructed of slats spaced one-half inch or more apart or of meshed wire fine enough to prevent the cones from falling through. (Fig. 18.) It should be filled about half full of opened cones and shaken vigorously. The seed will be dislodged and sift down through the openwork bottom.

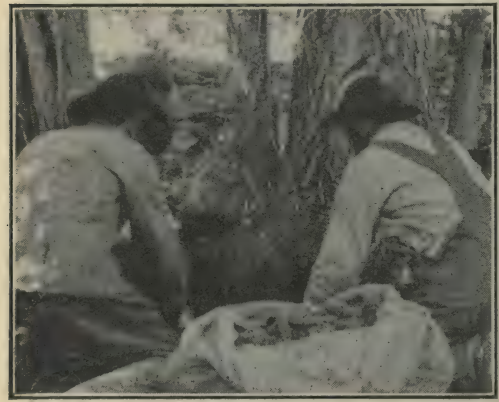
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FIG. 15.—Gathering cones from a squirrel hoard. Quantities up to 40 bushels have been taken from one hoard

A homemade churn shaker is an effective device, easy to make and to operate (fig. 19). It is a strong box about 3 by 3 by 4 feet (or some similar dimension which will not be too heavy to operate), with an iron or heavy wooden axle through its longitudinal center and a handle by which it can be rotated. The shaker is held up by the axle resting at the ends upon vertical supports, such as sawhorses or posts set in the ground. At least two sides of the box should be of slat or woven-wire construction, to allow the dislodged seed to fall out. One side of the box should be hinged, so that it may be opened to receive the cones and to discharge them after shaking. A barrel, the ends of which are screened with wire or slats, can be substituted for the box if it is more readily available.

The shaker should be turned rapidly enough to agitate the cones violently. Increased effectiveness results if medium-heavy blocks of wood are placed inside to rattle around with the cones and increase the jarring. If too heavy, these blocks will break the cones and crush some of the seed, thus increasing the chaff which will have to be screened out later.

All the cones will not open fully by any method of drying, and all the seed will not be dislodged by shaking. The best seed, however, will usually fall out. It will not pay to spend too much time trying to get all the seed or even the last 10 per cent.

CLEANING THE SEED

Cleaned seed is easier and more agreeable to handle than uncleaned seed. There is no real need for cleaned seed in a small home nursery, however, except that when the seed is clean it is easier to calculate the amount to sow in a bed. The thorough cleaning of coniferous forest-tree seed involves the removal of dust, cone scales, needles, and other forms of chaff, the separation of the wings from the seed itself in many cases, and the separation, so far as is practicable, of empty seed from those with a kernel.

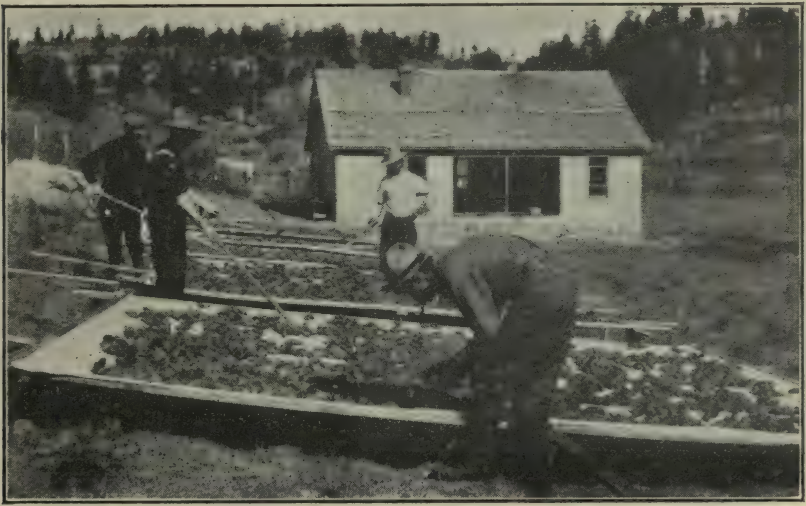

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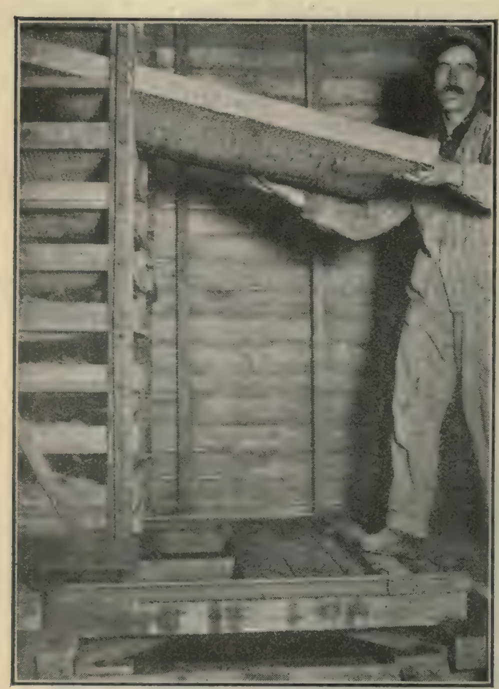
FIG. 16.—Pine cones spread out in the sunlight to dry and open

A great deal of the dirt and chaff mixed with the winged seed can be removed by using several screens of various-sized mesh. The material smaller than the seed can be removed by using fine screens, while the larger can be disposed of by sifting the seed through screens which will retain the coarser stuff.

REMOVING THE WINGS

Commercial seed establishments usually remove the wings of coniferous seed such as pine, spruce, and larch, which are not firmly attached to the seed itself or do not form an integral part of the seed coat. This is not necessary in seed collected for home use. The sprouting capacity of the seed is not improved by removing the wings. It is easier to handle and is worth more commercially. They can be removed by rubbing the winged seed through screens with a mesh slightly larger than the bare seed. The gloved hands, a stiff brush, a piece of carpet, or something similar can be used in this process. The seed should not be crushed. Another simple process is to place the seed in a sack and work it over with the hands or beat it with light flails. Neither of these methods is more than partially effective. They are more effective with pine and spruce if the seed is slightly moistened and allowed to stand in that condition for several hours before it is worked over. Such moistened seed must be thoroughly air-dried after the wings are removed.



F-10711-A

Fig. 17.—Interior of a seed-extracting plant. Handling a tray of cones

THE FINAL CLEANING

After the seed has been put through screens, considerable quantities of broken seed wings, light empty seed, twigs, resin, and other foreign matter will still be mixed with it. A portion of this material can be removed by winnowing. When a light breeze is blowing, the mixture of seed and chaff should be poured slowly from a box held at a height of 3 or 4 feet above the ground into another box placed on the ground. The height should vary with the strength of the wind. As the mixture falls, the wind will carry the lighter chaff away, while the heavy good seed will drop in the box below. By repeating this process several times, fairly clean seed can be procured.

In commercial operations, fanning mills are used to clean seed. Since such mills will seldom be found on farms, their use will not be discussed.

STORING THE SEED

When coniferous seed is not sown the same fall it is collected it can be stored in cloth or paper bags over winter. Heavy paper bags are preferable to cloth. The seed should be placed out of reach of rats, mice, and other rodents, and will keep better where the temperature is continually at the freezing point or lower. Seed of the true firs or balsams should be sown in the autumn as soon as collected, or, if necessary to keep it over winter, it should be mixed with moist sand or earth and stored in a cold place. Pine, Douglas fir, and spruce seed will keep best if, after being sufficiently dried to remove all moisture from the outer coating, it is placed in a dry and airtight receptacle. If stored in this manner these seed will still be good after several years.

GROWING THE SEEDLINGS IN THE NURSERY

LOCATION OF NURSERY

As a matter of convenience in handling, the nursery should be near the dwelling. To grow healthy, vigorous trees it should be located where the land is reasonably level and the soil fertile, well-drained, and deep. A sandy loam soil is preferable. Soil that will grow a satisfactory crop of vegetables will ordinarily grow good trees. The nursery should, if possible, be within reach of a sprinkling or irrigation system, because water is essential for satisfactory results.

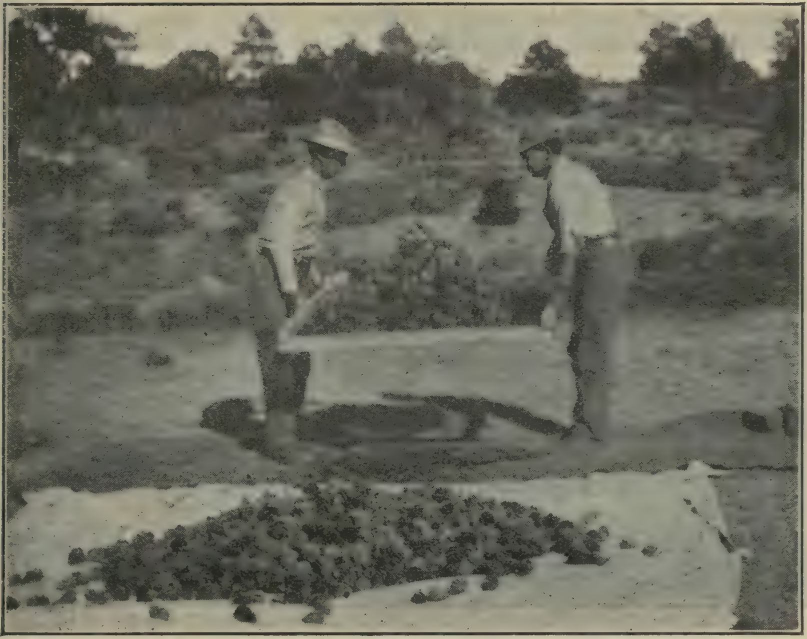


FIG. 18.—Shaking pine cones to jar the seed from them. Cones have been opened by exposing them to the sun

PREPARATION OF SOIL

The soil should be prepared with as much or even more thoroughness than for a vegetable garden. It should be spaded or plowed to a depth of a foot and all roots, rocks, or other trash removed. It should then be finely pulverized with a harrow or hand rake. The seed beds in particular should be put in a very fine state of tilth. It is a common practice to lay off seed beds 4 feet wide by 12 feet long, raised slightly so as to insure good drainage. In one bed of this size about 4,000 to 8,000 seedlings can be produced. The number of beds prepared will depend upon the number of trees that the owner wishes to grow. After the beds are laid out it is a good, although not essential, practice to roll or tamp them so as to firm the soil and smooth out irregularities.

TREATMENT OF SEED TO HASTEN GERMINATION

Coniferous seed does not always sprout readily. If it is to be sown in the spring, soaking it in water for about a week just previous to sowing is often recommended.

Eastern red cedar and presumably the other red cedars require special treatment, for the seed is inclosed in little blue or black berries which are pulpy and resinous. If sown without some treatment, the seed often does not sprout until the second spring or summer after sowing. It is desirable, therefore, to remove this pulpy substance before sowing the seed in the fall. Some nurserymen do this by running the berries through a meat grinder, the teeth of which are coarse enough not to crush the seed. Others soak the berries in water until the pulpy substance can be rubbed off between the hands, by means of brushes, or in any other way that will not crush the seed. The good seed will sink in the water, while the poor seed and a good part of the pulpy substance will float and can be skimmed off. The good seed should be sown at once at a depth of about one-half inch and the bed mulched with leaves or straw, or it may be stored in moist sand in a cold place over winter and sown early the following spring. In either case it usually sprouts satisfactorily.

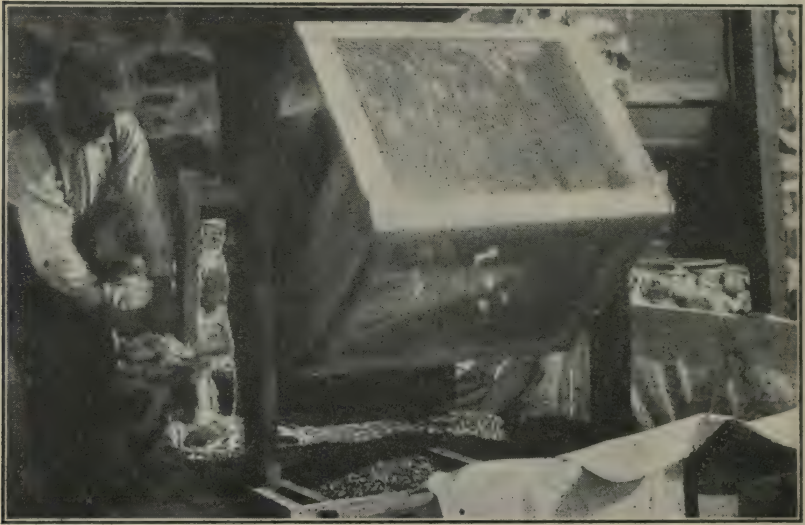


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FIG. 19.—Churning the dried cones to loosen the seed. Note that the seed is being shaken out and is falling through wire mesh to the ground

Another method which is said to have been used with success is to place the berries in a gunny sack and bury them in a manure vat over winter. The action of the heat and chemicals is such as to eat off the pulp, and germination follows readily when the seed is sown the following spring.

If the berries are mixed with moist sand in a box and buried out of doors from one fall until the second spring and then sown in beds, the seed will usually sprout freely.

SOWING THE SEED

SEASON

Coniferous seed can be sown either in the fall or in the spring. Some thin-shelled coniferous seed like that of the firs loses its vitality quickly. Longleaf-pine seed also appears to have this characteristic. The seed of eastern white pine, western white pine, sugar pine, eastern red cedar, the Pacific coast form of Douglas fir, and possibly others often does not sprout readily, particularly if the seed is old or has been improperly stored. Better results are ordinarily obtained from fall sowing of all such species. With other species, spring sowing is usually satisfactory, provided the seed has been properly stored over winter.

QUANTITY OF SEED TO SOW

The amount of seed to sow to a bed will be governed by its quality and by the number of seedlings which the owner wishes to produce. If procurable, only fresh seed of good quality should be sown; old seed is apt to be of little worth. An indication of the quality can be obtained by cutting 200 or 300 in halves and noting the condition of the kernels. If the kernels are for the most part white, plump, and greenish or yellow in the center, the seed should be good, although this is by no means an unfailing sign. A better method is to test the seed by sprouting a few on moist cloth or in moist sand in the same manner that corn or wheat is now very commonly tested before it is sown. The test should be started 60 days before the seed is to be sown, because some kinds of seed are very slow to sprout. Such a test will not always give a true indication of the percentage that will sprout in a nursery bed, since the germination in a sprouting test is usually higher. Nurserymen of considerable experience claim that 1 pound of fresh seed will produce approximately the number of seedlings indicated by Table 2.

METHOD OF SOWING

Coniferous seed can be sown in drills in much the same way that lettuce or radish seed is sown, or it can be scattered broadcast over the bed. The drills should be 4 to 6 inches apart and one-fourth to one-half inch deep. Small seed should be given a shallow covering; large seed a deeper one. In drill sowing the seed can be covered to the proper depth of one-fourth to one-half inch by filling the drills level full with soil after sowing. In broadcast sowing an easy way to cover the seed is to sift soil or sand over it through a wire screen of about one-fourth inch mesh. Sand is better than soil, because it sifts more easily and if clean usually contains very much less weed seed.

NUMBER OF SEEDLINGS TO GROW TO A SQUARE FOOT

In good soil 100 to 150 coniferous seedlings can be grown to a square foot of seed bed, provided they are not to be left beyond the age of 2 years (fig. 20). If the soil chances to be poor, infertile sand, or if the trees are to be left three or four years in the beds, this number had better be cut to 60 or 75. The amount of seed to sow to 100 square feet of seed-bed surface in order to produce 100 seedlings a square foot should be about as indicated in Table 2.

CARE OF SEED BEDS

COVERING THE BEDS

If seed is sown in the fall of the year and is not likely to sprout until the following spring, it is advisable to cover the beds with some material that will keep the seed from being washed out by heavy rains, heaved out by alternate freezing and thawing of the soil, or blown out by exceptionally severe winds. A single thickness of burlap or an inch or two of straw, hardwood leaves, pine needles, or hay may be used for the purpose. Hay is the least desirable cover, since it is likely to bring a good many grass or weed seeds to the beds which will later sprout and cause trouble. Rice straw is very good. Any of these must be held in place by sticks or light brush until the following spring. The cover should be removed as soon as the seed begins to sprout.

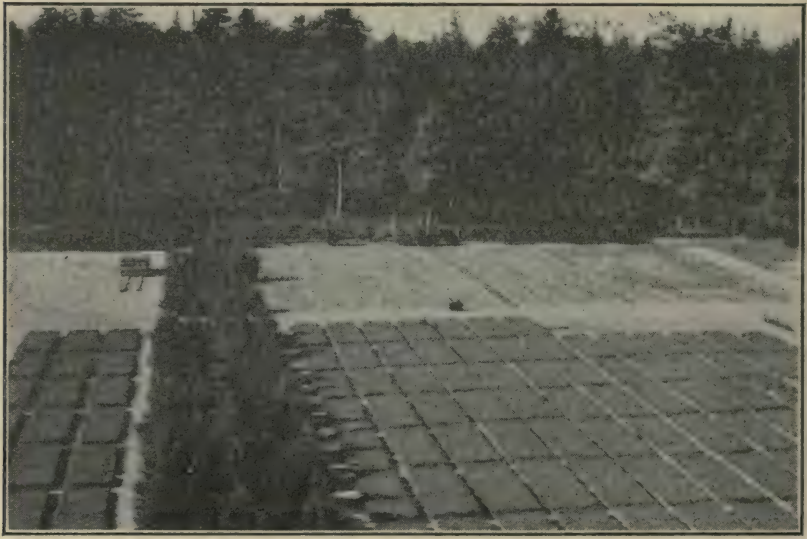
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FIG. 20.—A Michigan State nursery. In the foreground are beds containing 1 or 2 year old seedlings. Note how thickly they can be grown in a bed. Back of the nursery beds are small trees which have been transplanted in long rows. The five rows of trees to the left of center serve as a windbreak

WATERING

The seed beds should be watered when the soil is dry, first to induce sprouting of the seed and later to prevent the dying of the seedlings from lack of moisture. The beds should not be water-soaked, but should be kept just moist enough to insure good growth. Excessive moisture is not desirable, because it keeps the soil cold and sometimes makes conditions favorable for the development of a disease, "damping off," which is very destructive to young seedlings.

SHADING

During their first summer and especially during the first six or eight weeks of their life coniferous seedlings are tender and liable to serious injury from the sun's heat. The surface of the soil often becomes extremely hot on bright, warm days, and the tender stems are virtually cooked. The spruces, firs, cedars, and hemlocks are perhaps the most susceptible to injury of this kind, although any species may be affected. Shading of the beds is the means of prevention. Moreover, if it is out of the question to water the beds, shade will supplant water to a limited extent. Shaded soil will not dry out so rapidly as unshaded, and in consequence the plants will suffer less from lack of moisture. On cloudy days or when the air is cool shade is not necessary. It is most needed during the several hours of extreme heat in the middle of bright, hot summer days.

Shade can be provided by any rough means that comes to hand. One simple method is to drive short pieces of 2 by 4's at 10 or 12 foot intervals along both sides of the beds until their tops rest 16 to 20 inches above the surface. Each line of posts should then be connected at their tops by 1 by 4 stringers. This makes a framework upon which brush, boards, or other material that will cast a shade can be piled (fig. 21). A lath frame like that shown in Figure 22 is commonly used in large nurseries.

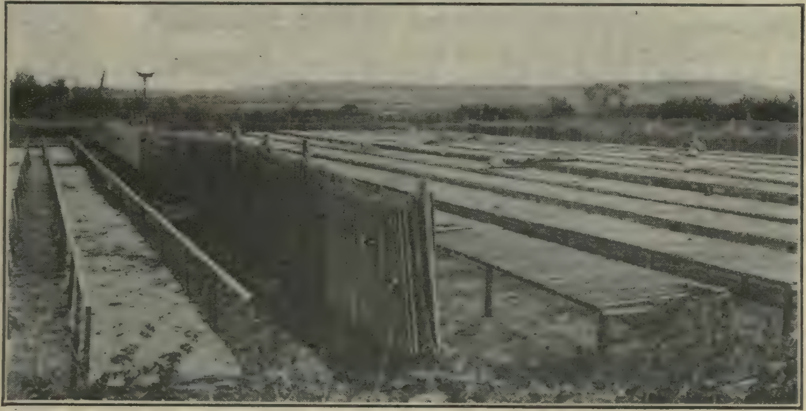

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FIG. 21.—This type of shade frame is easy to construct. Brush can be used in place of lath to shade the seedlings

In their second and third years in the beds, coniferous seedlings are less liable to injury from sun or drought. Shade is then less necessary, particularly for pines. All seedlings should be carefully observed, however, and if damage is evident and water is not available, shade should be provided.

PROTECTION

The seed beds must be fenced against poultry and livestock. Mice may dig up and eat the seed, and birds often cause trouble by picking off the tops of the seedlings shortly after the seed sprouts. Both mice and birds can be kept out of the beds by use of the protective screen illustrated in Figure 22. To be effective against mice, the wire hardware cloth used in its construction should be of one-half inch mesh or less. Traps can be used for mice and one or two house cats usually afford some protection against them.

Damage from early fall and late spring frosts must be guarded against by covering the beds on frosty nights in the same way that vegetables are covered. The shade frame is usually a fairly effective protection under such conditions.

On heavy soil, 1-year-old seedlings may be heaved out of the beds by frost. On light soils in regions of cold winters but little snow, the small trees may be killed by winter drying. Where either danger is known to exist or is probable, the beds should be mulched lightly with pine needles, hardwood leaves, or straw, or the shade frames may be left on all winter. Care must be exercised not to overmulch, because the leaves or other material may become soggy and packed and smother the small plants. The mulch should be removed just as early in the spring as the weather permits.

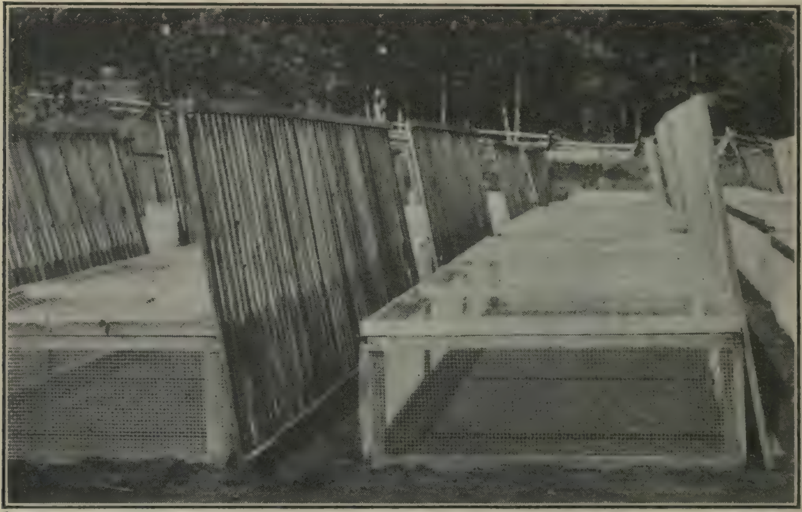
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FIG. 22.—This type of frame affords seed and seedlings protection against birds and mice as well as against sunlight

"Damping-off" is a disease which attacks seedlings during the first few weeks of their life. It causes the stems to turn watery and limp, and the plants to fall over. In some large nurseries, a greatly diluted solution of sulphuric acid is used to combat the disease; in others, formaldehyde has been found more satisfactory. Covering the seed with clean sand rather than soil seems to be a partial preventive. The seed beds should not be fertilized with fresh manure, wood ashes, or lime.

WEEDING

To promote the best growth of the seedlings, the beds should be kept free of weeds. Weeding by hand is essential if the seed is sown broadcast. Garden tools may be used if the seed is sown in drills.

An application of $1\frac{1}{8}$ ounces of zinc sulphate diluted in 1 gallon of water to each 4 square feet of seed bed immediately after sowing effectually killed weed seed in one nursery and proved in no way injurious to the seed or seedlings of western yellow pine and western white pine produced there. It is not known whether such an application would damage other species.

TRANSPLANTING

By transplanting is meant the transfer of the seedlings from the seed beds to other beds, where the small trees are set out 2 or 3 inches apart in rows 4 to 6 inches apart. The object of transplanting is to retard the growth of the tops and stimulate root development. The result is usually a compact, bushy top and a much-branched, fibrous root system. (Fig. 23.)

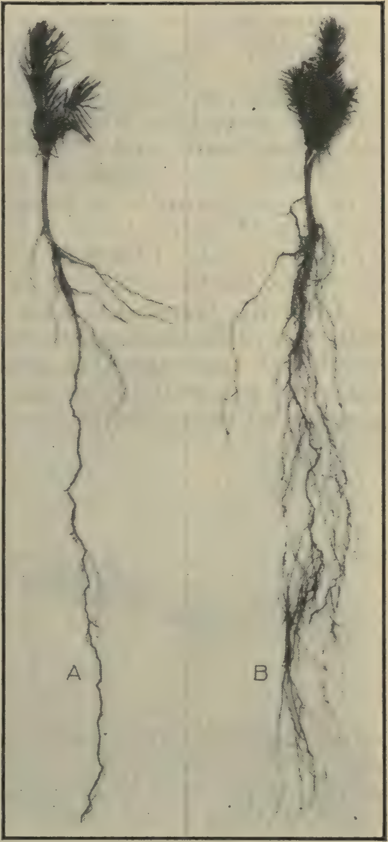

FIG. 23.—(a) Three-year-old Engelmann spruce seedling; (b) 3-year-old Engelmann spruce transplant. Note the greater quantity of fine roots of the transplant. For this reason transplants are usually better than seedlings for planting where conditions are not favorable

NECESSITY FOR TRANSPLANTING

Transplanting is not always a necessary operation. Strong 1 or 2 year old seedlings 4 inches or more in height will often succeed under favorable conditions when planted in the field directly from the seed bed. This appears particularly true of loblolly, shortleaf, and slash pines. After one or two years in transplant beds, however, coniferous trees in general are well suited for planting in the field and stand a very good chance of living even if the conditions are not particularly favorable. They are much more likely to live than seedlings on poor, shallow, or infertile soil, or areas covered with brush or heavy long grass, on extremely sandy soils, or on hot, dry exposures such as south and west slopes of hillsides.

AGE AT WHICH TO TRANSPLANT SEEDLINGS

When seedlings reach a height of 3 inches they are large enough to transplant. They will usually be 2 years or more of age, although some will be as tall or taller than this when only 1 year old.

SEASON TO TRANSPLANT

The young trees should be transplanted when growth is dormant, and preferably just before the rainy season commences. This means early spring in the northern part of the United States, but may mean late fall or even winter in some of the Southern States. Spring transplanting is decidedly preferable in regions of light snowfall which are subject to periods of extremely cold weather during the winter months.

PREPARATION FOR TRANSPLANTING

The first step in transplanting is to put the soil of the transplant area in good tilth by spading and raking. It should be free of sticks and trash, and of rocks if possible. A bed 6 feet wide is a convenient size for working. Assuming a spacing of the plants 2 inches apart in the rows and the rows 6 inches apart, a bed 6 feet wide would have to be about 14 feet long to hold 1,000 transplants. If the rows were 12 inches apart, to permit cultivation with an ordinary hoe, the bed would of course have to be about 28 feet long.

After the transplant beds are prepared, the soil should be well watered. The seedlings should then be dug from the seed beds and carried to the transplant area. In digging, every effort should be made to get well under the roots to avoid breaking them. The greatest of care must be exercised to keep the roots from becoming dry, because a few minutes' exposure, particularly on a hot, windy day, will often dry up the sap in the roots and kill the young trees. Although the tops may still appear perfectly fresh, any subsequent effort spent in transplanting will be wasted. It is preferable, therefore to do the transplanting on cloudy, cool, calm days, to dig the seedlings only a few at a time as they are needed, and to keep the roots covered with damp soil, damp moss, or damp cloth until the plants are set in the transplant beds.

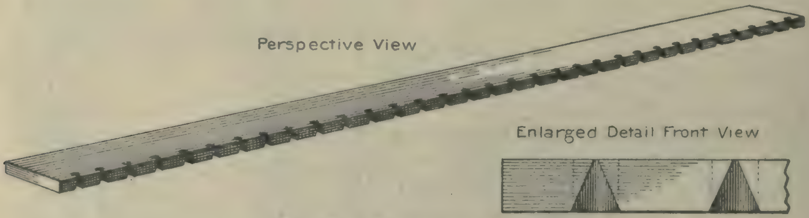

FIG. 24.—Transplant board

THE TRANSPLANTING OPERATION

The operation itself is not difficult. One of the simplest means is to use a board 1 inch thick, 6 inches wide, and 6 feet long. Evenly spaced notches should be cut along one edge to hold the seedlings. (Fig. 24.) The board is laid flat on the ground across the bed with its unnotched edge along the line where the first row is to be transplanted. A trench 6 inches or more deep, with its vertical side along the edge of the board, is then excavated. (Fig. 25.) As the soil is removed it is placed directly in front of the trench for use later. The board is then reversed, so that its notched edge projects slightly beyond the vertical face of the trench. The small seedlings are strung upright, one in each notch, so that the lower leaves rest on the upper surface of the board and the roots rest along the vertical face of the trench and hang toward the bottom. (Fig. 26.) The loose dirt removed in making the trench should be pulled in and tamped firmly around the roots. An inch board 6 to 8 inches long serves well for that purpose. The transplant board should then be disengaged from the tops of the seedlings by tipping it forward on the notched edge and drawing it slowly backward. The same process should be followed with the next row, and so on until the transplanting is done. With a little practice a man can transplant several thousand plants a day. It is advisable to give the beds a good soaking with water at the end of each day's transplanting. This settles the soil around the roots, helps the plants to recover from the shock of transplanting, and is a partial insurance against heavy losses.

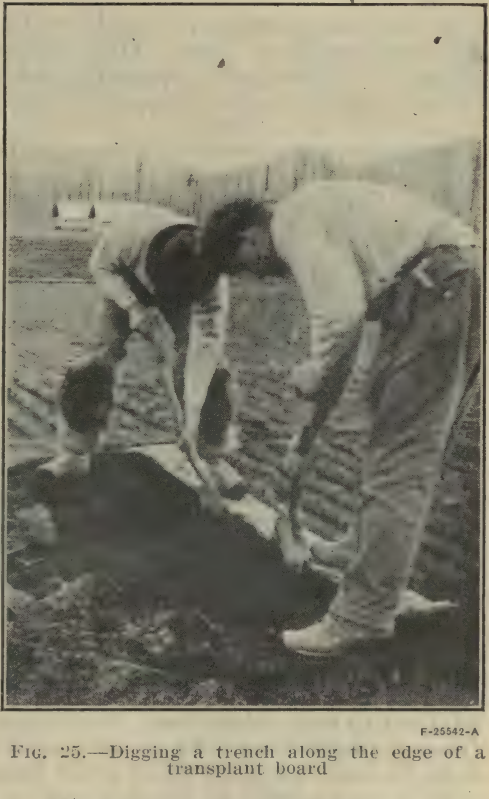

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FIG. 25.—Digging a trench along the edge of a transplant board

CARE OF TRANSPLANTS

Transplants generally need little care other than weeding, watering in dry weather, or shallow cultivation in place of watering, and protection against livestock. Where light snowfall and extreme and protracted cold characterize the winters, the young trees may have to be mulched with leaves, hay, straw, or similar material.

LENGTH OF TIME IN TRANSPLANT BEDS

One year is commonly long enough for pines or any other vigorous-growing conifers to remain in the transplant beds, unless they are to be planted where the conditions for growth are unusually adverse. Trees left for two years in the transplant beds generally succeed better on areas covered with a rank growth of grass, bushes, brush, or second-growth timber. Slow-growing species, such as spruces and firs, often require two years in the transplant beds for satisfactory development. Transplants 4 to 6 inches high, with healthy, vigorous, bushy tops and a good bunch of fine roots, are ordinarily large enough and entirely satisfactory for field planting.

STARTING THE PLANTATION

SITES WHERE SUCCESS IS DOUBTFUL

While such species as southern white cedar, northern white cedar, tamarack, southern cypress, and black spruce occur naturally in very swampy areas, it is not suggested that such areas be planted, because too little is known of the probable success which would attend the venture. In Europe, swampy areas are sometimes planted. They are usually drained by ditching, however, or the trees are planted at the apex of mounds of soil, where the roots will not be immersed in water.

A wind-swept seashore is a difficult site on which to secure a satisfactory growth of trees. Only the most hardy species should be planted. Even then the trees nearest the water are extremely likely to be dwarfed and distorted. Native species are ordinarily best adapted to such situations. In Europe, Corsican pine is planted on these exposed sites, and it may do well under these trying conditions in some parts of the United States.

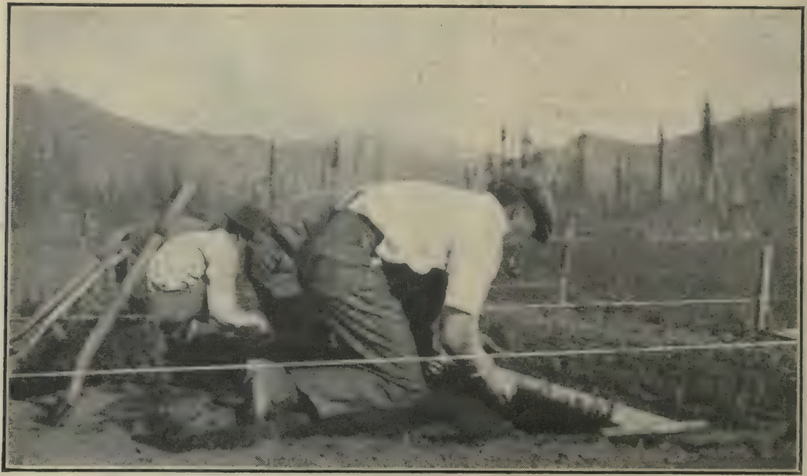

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FIG. 26.—Transplanting seedlings by means of a transplant board. Seedlings are strung in notches at edge of board

It is inadvisable to plant a site on which a dense young thrifty growth of commercially valuable hardwood seedlings or sprouts, such as oak, ash, birch, maple, yellow poplar, etc., is already present. If such an area is planted to pine, spruce, or other conifers there will be a continuous battle for space and light between the hardwoods and the conifers, and, unless given help in their early years, the conifers are more than likely to be smothered by the falling leaves of the hardwoods, overtopped and shaded out, or whipped out by the hardwood branches. In order to bring the conifers through under such conditions, it will usually be necessary to plant relatively large trees and to cut out the hardwoods from around each planted conifer one or more times at intervals of two or three years. This is a laborious, expensive, and scarcely worth-while undertaking. It is better to let the hardwoods grow in such situations. Where the hardwoods are rather widely scattered, however, or consist of scrubby or short-lived and scant-foliaged species, such as scrub oak, fire cherry, persimmon, and sassafras, the area may safely be planted to conifers. Brushy and brier-covered areas also can ordinarily be planted with assurance of success. It is usually best under such conditions to plant in the openings rather than to set the trees where they will be densely shaded. Trees do not thrive for any length of time if heavily shaded; they prefer the sunlight.

PLANTING WILD STOCK

A good many plantations of eastern white pine have been started by using wild seedlings dug up in near-by fields or pastures. (Fig. 5.) Some shortleaf, slash, and loblolly pine plantations have been started in the same way. Experience indicates, therefore, that if properly handled it is possible to use such seedlings with success, and the practice could doubtless be extended to other species. Digging the seedlings from the field is ordinarily a rather slow process, and if performed by hired labor, a costly one. Such trees might cost more than trees of equal or better quality for the same purpose purchased from a nursery. Aside from the matter of expense, the wild seedlings do not usually have as good root systems as those grown in nurseries, and unless weather conditions are very favorable after they are planted many are likely to die. Everything considered, the use of wild stock is not generally recommended. However, if the labor cost is not excessive and the wild stock is to be had for the digging, there appears to be no serious objection to using it. The seedlings should be dug rather than pulled, in order to secure as much of the roots as possible, and the roots should be kept moist from the time the trees are dug until they are planted. If available, plants 6 to 8 inches in height should be chosen rather than larger ones, because they will succeed best.

PLANTING LONGLEAF PINE

Longleaf pine is a species that has been planted very little. When 4 to 6 inches tall it has a long, thick taproot which makes successful planting difficult. If longleaf pine seed is gathered as soon as ripe in the fall and sown immediately in a seedbed, it will sprout and make some growth during the same season. It will not develop very much by spring, however. The small seedlings can be dug early in the spring and planted in the field simply by scooping out holes with a shovel, hoe, or garden trowel and setting one plant in each hole. One plantation of which there is record was started in this manner. The method appears to offer the most reasonable chance of success of any planting method so far tried with longleaf pine, although experience with it is limited.

SOWING SEED

As a means of starting a plantation of coniferous trees, sowing the seed directly on the area is a gamble, with small chance of success. In the vast majority of cases where it has been tried in this country, the method has been a failure, and it is not generally recommended. The seed is eaten by rodents and birds, and seedlings which do start are killed by disease, frost, insects, animals, and drought. Of course some pass through all these dangers and successful plantations occasionally result. There are records of such plantations of white, pitch, longleaf, slash, loblolly, and western yellow pines, and probably other conifers. The method has not yet been given as thorough a trial with southern pines as with northern and western species, and may prove to be more generally successful with them.

Sowing seed broadcast on plowed or thoroughly disked land and then brushing it in with a harrow appears to offer more assurance of success than other methods. At least 1 or 2 pounds of seed should be broadcasted to the acre. Less seed will be required if it is sown in hills or spots spaced 6 or 7 feet apart. The soil in each spot should be dug up and pulverized; several seed should then be sown and covered with one-quarter to one-half inch of soil.

SPACING OF TREES

IN GROVES

In order to utilize the land fully and to promote upright growth, forest trees should be planted rather close together. It is a common practice in the United States to set out 700 to 1,200 trees to the acre. It will be found suitable under most conditions to set out approximately 1,000 per acre. This means they should be spaced about 6½ feet apart.

IN WINDBREAKS

The desirable spacing in windbreak planting will depend largely upon the character of the windbreak. If it is to consist of a single row of trees they should be set out about 4 feet apart. Northern white cedar (arborvitæ) should be spaced 2 feet apart. If of two or more rows, they can be set 6 to 8 feet apart and arranged so that each tree in one row will fall midway between two trees in an adjacent row. A very effective windbreak for the protection of buildings and feed yards will consist of two rows of coniferous trees and then another row about 2 rods distant. The intervening 2-rod space will serve as a trap in which snowdrifts will form rather than to the leeward of the windbreak.

TIME TO PLANT

In regions of severe winters, early spring is generally considered the best season to set trees out in the field. This means just as soon as possible after the frost is out of the ground. Success has attended fall planting in such regions, however, particularly when the snow comes early in the winter and remains late in the spring. Spring planting is also considered essential to success in the arid portions of the Western States, particularly in the intermountain region. If planted in the fall in that region, the foliage of the small plants may be subjected to severe drying by the atmosphere because of the low humidity often prevailing at that time. If the roots are not well enough established in the soil to supply the foliage with moisture, a condition often made more serious by the freezing of the soil, death of the trees commonly results. In regions of mild and humid winters, planting may be carried on either in the spring or the fall, with admirable chances of success if other factors are favorable. Land should not be planted at any season unless the soil is moist. It is desirable to pick cool, foggy, or drizzly days for planting.

ORGANIZATION OF CREW

For a small planting operation a crew of eight men is a good unit for rapid work. They will set trees on four or five acres each day. If the trees are planted in holes, four of these men equipped with grub hoes will dig the holes; the other four will follow and plant the trees. If the trees are set in slits or clefts, each man makes the slits and plants the trees also. The men with the grub hoes will travel abreast and make the holes 6 to 7 feet apart in a line across the area being planted.

The rows of trees can be kept reasonably straight by lining up poles across the field to which are attached bits of white rags or paper. These can be moved over as the planters come back across the field. There is no need of perfectly straight lines but there is less confusion in planting if they are reasonably straight.

METHOD OF PLANTING.

Since forest trees are usually allowed to shift for themselves after they are in the ground, they should be given a good start by careful planting. The roots of pines, spruces, and other evergreens will not stand drying. The plants should therefore be carried in a bucket with the roots immersed in water or thin mud, or in a box or basket where the roots can be covered with wet moss, wet burlap, or similar material. After choosing the spot where a young tree is to be set, the sod or weeds should be scraped off for a space 14 to 16 inches square. A hole should then be dug large enough to accommodate the roots when they are well spread out. The better top soil removed should be placed in a separate pile from the poorer soil, for use later. The seedling should be set in the hole with its roots well spread out, and the better top soil pulled in over the roots and packed down firmly with the closed fist. Loose trash, grass, weeds, moss, etc., should not be pulled in around the roots, since such material can not be packed tightly and will be the cause of the roots drying out and the consequent death of the plant. Additional soil should be pulled in to fill the hole to the ground level and firmed. Then a shallow layer of soil should be drawn around the tree and left loose to act as a mulch.

Where the soil is sandy and free from rocks, planting has been successfully carried on by setting the seedlings in wedge-shaped slits or clefts. These clefts are made by driving a spade or similar tool in the soil to the full depth of the blade and working the handle backward and forward. The roots are then inserted in this V-shaped opening, and the soil is pressed around them with the foot or by again driving the spade in the soil about 4 inches distant and forcing the soil over against them. Although this method is not so sure as planting in holes, it can be carried on fully twice as rapidly.

If the ground can be plowed before planting, or even single furrows made 6 or 7 feet apart across the field, planting can be carried on more rapidly in the bottom of each furrow and with better prospects of success. The plowing will turn under some of the grass and brush that would otherwise compete with the trees for moisture (fig. 27). In the naturally treeless regions preparations of the soil appears essential for satisfactory results.

One man can ordinarily plant 500 to 1,000 seedlings a day, depending upon the soil, the cover, the day, the man, and other factors. More than 1,000 have often been planted and less than 500.

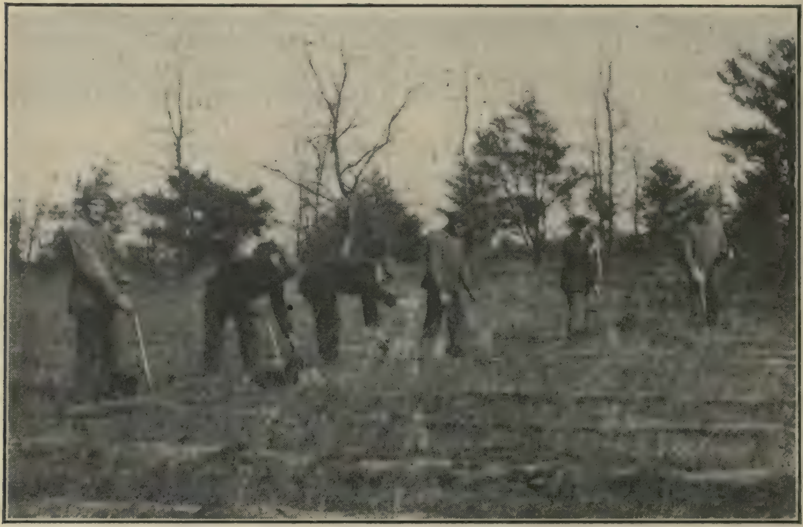

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FIG. 27.—A tree-planting crew at work in Michigan. Trees can be planted better and more rapidly in furrows

If unplanted trees remain in the pails or baskets at the end of a day's work, the roots should be covered with sufficient water or moss to prevent drying out over night. It is best, however, to dig no more plants from the beds each morning than can be planted during the day.

CARE OF THE PLANTATION

CULTIVATION

In those regions where conifers occur naturally it is unnecessary to cultivate plantations. Where they can be cultivated for two or three years just as corn would be, fewer trees will die and initial growth will be more rapid. In the treeless regions cultivation is essential to prevent heavy losses and to insure satisfactory growth.

LIBERATION CUTTINGS

When coniferous trees are planted in brush or among hardwood sprouts, the hardwoods will often outgrow the planted trees for several years, and overtop and eventually kill them by crowding or shading. Under such a condition it is necessary to cut back such brush or hardwood growth. This so-called "liberation cutting" should be carried on in midsummer, when the leaves are out. It is easier to determine at that time what brush or sprouts should be cut. Cutting is usually necessary about three years after planting. It may have to be repeated two or three times before the conifers begin to outgrow and reach above the brush or sprouts.

THINNING

When the trees reach an age of 15 to 20 years they will usually crowd each other rather severely and appear to be standing too close together. Some of them will be dead or dying and some will be much smaller than others. The lower limbs will be dead or dying, and a few will have fallen off. These are all good signs; the plantation has developed as it should to produce timber of high quality. There is need at this time, however, to cultivate with an ax—to make a "thinning." The dead and dying trees should be cut and salvaged for cordwood, bean poles, or similar material. Other trees of inferior form which are crowding better trees and any diseased or damaged specimens should also be cut. When a portion of the trees is removed in a thinning, those remaining have more room, light, and moisture, and they respond with increased growth. When thinnings are repeated several times during the life of the plantation, the final result is a stand of large trees of fine quality. In unthinned woods the final result is a stand consisting of some fine, large trees mixed with a considerably larger number of inferior, smaller ones. In making thinnings the crown cover should not be opened to such an extent that a great deal of sunlight will strike the ground under the trees, because this will dry out the soil, give rise to a growth of weeds and grass, and make conditions in general less favorable for the growth of the remaining trees.

PRUNING LIMBS

When trees are planted close together in a body, the limbs of adjacent trees will touch and crowd each other in 7 to 10 years and the shade will gradually kill the lower limbs. Some trees shed dead limbs rather quickly; others retain them, or at least the stubs, for a long time. It is not uncommon for eastern white pine and Norway spruce, for example, to retain the dead stubs of lower limbs up to 50 years of age. Limbs cause knots, and knotty logs are less valuable than smooth logs. When the timber has a high commercial value and when the cost of the operation is not excessive, pruning the limbs from coniferous trees appears to be justified. If, for instance, the owner of such trees can utilize his own spare time to saw off the lower limbs to a height of 13 to 17 feet, when the trees are not yet over 4 or 6 inches in diameter, he will be well repaid for his efforts in the increased value of the butt logs. This has proved true in the case of eastern white pine in New Hampshire. It is best to saw the limbs off as close as possible to the trunk of the tree. The wounds will then heal quickly, and butt logs will be smooth and will saw out a large proportion of clear lumber. None but the most thrifty and rapid-growing trees should be pruned, because the small and stunted individuals are almost certain to be killed by crowding before they reach saw-log size.

PROTECTION

Trees in plantations are subject to various injuries, some of which are difficult to combat. If rodents, insects, or diseases cause trouble, it is best to seek a remedy through the State forester, State agricultural college, or the United States Department of Agriculture. Special attention should be given to protecting white-pine plantations from the white-pine blister rust[4] and the white-pine weevil.[5] Damage from severe winds, snow, and ice storms may take place, and can scarcely be guarded against. Injury from fire and livestock can and should be avoided. Young coniferous trees are readily killed even by grass and leaf fires. Larger trees are often severely burned and are later attacked by diseases or insects through the fire-caused wounds. Such trees lose a great deal in value from the deterioration of the butt log. Every reasonable means should be taken, therefore, to keep fire out of a plantation. A fire of short duration will undo the work, care, and expenditure of a number of years. Vigilance should be used to detect and suppress any fires that occur in or near a plantation. A fire line may be constructed around the plantation if it is possible to do so. A fairly effective fire line can be made by plowing a strip 8 or 10 furrows wide entirely around the plantation or along those sides from which fire may come. If kept clean, such a fire line will stop an ordinary leaf or grass fire or will make it possible to halt the fire there.

Horses, cattle, and sheep often do considerable damage to young conifers by trampling and browsing, and in fly time by brushing against and breaking them; hogs root up the soil and small trees. Any of these animals injure the older trees by trampling and packing the soil around the roots, thus shutting off the air and water supply and even exposing and skinning the roots themselves. This often causes the gradual dying of the tops. Damage of this sort is usually serious only when the woods are heavily pastured or when the ground is very soft. There are times when it may even be advantageous to turn sheep in a plantation where conifers are set among hardwood brush or sprouts. Sheep prefer to browse on the hardwood leaves and twigs, and when hardwoods are browsed off the conifers have a better chance to develop. Except to accomplish that purpose, livestock has no place in a well-cared-for plantation.

GROWING CHRISTMAS TREES

Every year several million coniferous trees, varying in height from 1 to 15 feet or more, help to make the Christmas season a festive one. The greater number are probably 4 to 8 feet tall. Many come from the hillsides and pastures of farms, particularly those of the Northern States, where spruce and firs, the trees most cherished for the purpose, occur in greatest abundance. In 1924, spruce and fir trees commonly sold for $1 to $3 and more on the streets of the larger eastern cities. Retail prices have increased several hundred per cent in the last 15 or 20 years. High prices appear likely to prevail in the future, and in consequence growing Christmas trees in plantations near the large consuming centers is beginning to look like an attractive business proposition. This is particularly true for centers in the Eastern and Middle Western States which are rather distant from a natural source of supply. Several such plantations are already in existence, from which trees have been sold at prices ranging from 50 cents to $1.50 each (fig. 28). In a plantation adjacent to a good public road it seems probable that all trees could be sold right on the ground to people passing in automobiles.

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[4] Full information as to methods can be procured from the Office of White Pine Blister Rust Control, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

[5] Information in regard to the white-pine weevil may be had from the Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Christmas trees should be given more care than the ordinary forest plantation. The trees should be set out on land prepared by plowing as for any field crop. After the trees are planted they should be cultivated for two or three years in the same way that corn is cultivated. Since the trees will be grown for only 5 to 8 years and in no case perhaps over 10 years after they are set out, they can be planted at the rate of about 5,000 per acre. A triangular spacing of 3 by 3 feet will mean about 5,600 per acre.

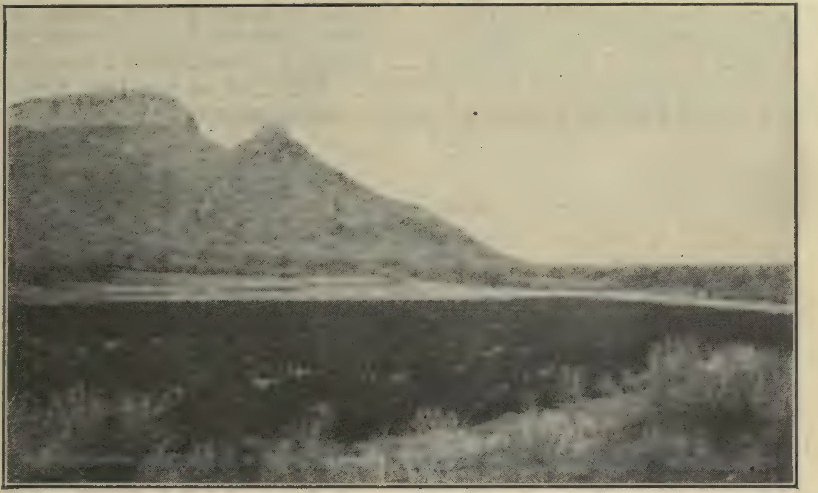

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FIG. 28.—Nine-year-old red cedar plantation in Comanche County, Okla., from which Christmas trees have been sold on the ground for 75 cents to $1 each.

The trees will not all grow at a uniform rate. It will be possible to harvest some in 4 or 5 years after planting, and others in each succeeding year. Excessively rapid growth should not be sought, for slower-growing trees are more compact and better liked for Christmas-tree use.

In the region east of the Rocky Mountains, the trees likely to command the highest prices are the spruces and firs. These can not be grown everywhere, but where they can (as indicated in fig. 4) they are the logical choice for planting. If Norway spruce is adapted to the locality, it is preferable to other spruces listed, because it grows more rapidly. In those Southern States where small native pines are very plentiful and commonly used for Christmas trees, it is doubtful if plantations would at present yield satisfactory financial returns. The same is probably true for the region from the Rocky Mountains to the Pacific coast, where coniferous trees are either abundant locally or can be shipped in from a short distance.

In starting a plantation of this character, it seems desirable to use good sturdy trees, preferably transplants about 4 years old. They will take hold readily and begin to grow the first year. Small, weak trees, on the other hand, will be slow to start and will require 2 or 3 years longer than transplants to reach a salable size.

Results gained in a plantation of red cedar in western Oklahoma, where red cedar grows better than other conifers, indicate that at least two crops of Christmas trees may sometimes be secured from one setting of trees. When the first crop was harvested in this plantation, the trees were cut off just above the large lowest limbs. All but the strongest one of these limbs was then cut. In the course of a year or two this limb assumed an upright growth and a few years later another Christmas tree resulted. Whether or not this practice will succeed with all species of conifers is unknown.

APPENDIX

State forestry departments, April 25, 1925

State	State forester or similar officer
Alabama	State forester, Montgomery.
California	State forester, Sacramento.
Colorado	State forester, Fort Collins.
Connecticut	State forester, Hartford.
	Forester of the agricultural experiment station, New Haven.
Idaho	State forester, Boise.
Illinois	State forester, Urbana.
Indiana	State forester, Indianapolis.
Iowa	Forester of the Iowa Agricultural College, Ames.
	State forestry commissioner, Des Moines.
Kansas	State forester, Manhattan.
Kentucky	State forester, Frankfort.
Louisiana	Superintendent of forestry, New Orleans.
Maine	Forest commissioner, Augusta.
Maryland	State forester, Baltimore.
Massachusetts	State forester, Boston.
Michigan	Director, department of conservation, Lansing.
Minnesota	State forester, St. Paul.
Montana	State forester, Missoula.
New Hampshire	State forester, Concord.
New Jersey	State forester, Trenton.
New York	Superintendent of State forests, Albany.
North Carolina	State forester, Raleigh.
North Dakota	State forester,[6] Agricultural College.
Ohio	State forester, Wooster.
Oregon	State forester, Salem.
Pennsylvania	Secretary, department of forests and waters, Harrisburg.
Rhode Island	Commissioner of forestry, R. F. D., East Greenwich.
South Dakota	Forest supervisor, Custer.
Tennessee	State forester, Nashville.
Texas	State forester, College Station.
Vermont	Commissioner of forestry, Montpelier.
Virginia	State forester, Charlottesville.
Washington	State supervisor of forestry, Olympia.
West Virginia	Chief game protector, Buckhannon.
Wisconsin	Superintendent State forests and parks, Madison.

[6] Position designated by governor; not provided for by law.

States which maintain forest tree nurseries and are authorized to distribute small trees to any resident of the State for forest planting

[Address State Forestry Department (as above), unless otherwise indicated]

Maine.
New Hampshire.
Vermont.
Massachusetts.
New York.
Pennsylvania.
Idaho (address University of Idaho School of Forestry, Moscow).
Maryland.
Virginia.
Louisiana.
Ohio.
Michigan.
Wisconsin.
Kansas.
Indiana.
Washington (address State College of Agriculture, Pullman).
Colorado and New Jersey distribute trees but do not maintain nursery.

Some U. S. Department of Agriculture forestry bulletins of interest to farmers and available free upon request

Farmer's Bulletin No.	Title
744	The Preservative Treatment of Farm Timbers.
1071	Making Woodlands Profitable in the Southern States.
1110	Cooperative Marketing of Woodland Products.
1117	Forestry and Farm Income.
1123	Growing and Planting Hardwood Seedlings on the Farm.
1177	Care and Improvement of the Farm Woods.
1210	Measuring and Marketing Farm Timber.
1256	Slash Pine.
1312	Tree Planting in the Great Plains Region.
1405	The Windbreak as a Farm Asset.

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June 25, 1925

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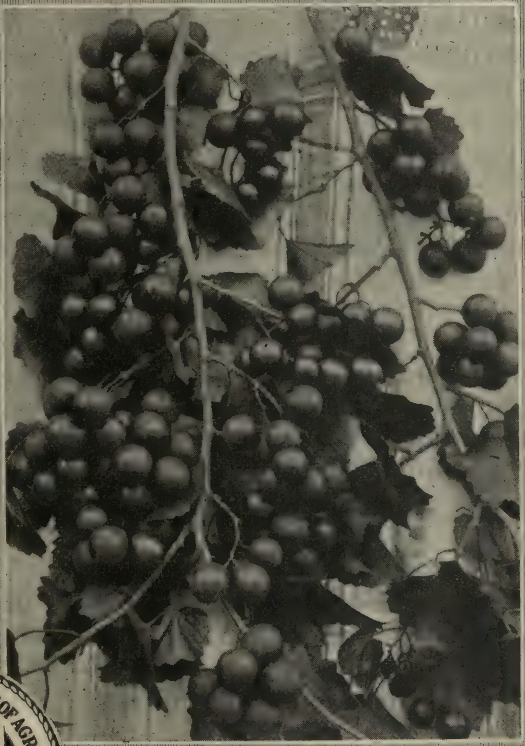
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1454

HOME UTILIZATION OF MUSCADINE GRAPES



THE HOME UTILIZATION of Muscadine grapes in those portions of the South Atlantic and Gulf States in which they are widely grown has much to commend it. This is one of the most common types of fruits that is to be found in the Coastal Plains sections of these States. A few vines well cared for will produce an abundance of fruit for the ordinary family. The vines are frequently grown on arbors, thereby furnishing shade as well as fruit.

Though Muscadine grapes are very common, the ways in which they have ordinarily been utilized in the past have been limited, and in some seasons much fruit has been wasted. These grapes have been used mainly in the fresh state, for canning, and for a few culinary purposes.

During recent years considerable attention has been given to working out new methods of using Muscadine grapes in the home, and as a result it is now possible to make a number of delicious products from them. Members of Home Demonstration Clubs for both women and girls in the South Atlantic and Gulf States have become interested in making these products, and for several seasons past they have produced them in increasing quantities. While made only for home use in many cases, large quantities of several highly standardized products are profitably marketed each year by club members.

This bulletin is intended as a guide for those who may desire to give attention to the better utilization of Muscadine grapes. The housekeeper who is accustomed to prepare fruit products in considerable variety will readily devise other ways than those described in this bulletin.

This bulletin combines and supersedes the three publications formerly issued as Farmers' Bulletins Nos. 758, "Muscadine Grape Sirup;" 859, "Home Uses for Muscadine Grapes;" and 1033, "Muscadine Grape Paste."

Washington, D. C. Issued September, 1925

HOME UTILIZATION OF MUSCADINE GRAPES

By CHARLES DEARING, *Associate Horticulturist, Office of Horticultural Investigations, Bureau of Plant Industry*

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IMPORTANCE OF A BETTER UTILIZATION OF MUSCADINE GRAPES

A LARGE surplus of Muscadine grapes which may be profitably utilized at home in culinary ways is allowed to go to waste each year. Although in past years the production of these grapes assumed some commercial importance, their utilization was confined almost entirely to consumption in the fresh state and formerly to wine making. The utilization of the fresh fruit has been limited by the poor shipping qualities of the best table varieties and the lack of adequate transportation facilities. The result of this condition is a surplus supply of fruit at home. The small vineyardist sells what fruit he can locally, and the family of the farmer having an arbor of one or two vines uses such fresh fruit as the members care to eat. The remainder, with few exceptions, is allowed to fall to the ground and decay, though it could be utilized profitably in culinary ways. These uses of Muscadine grapes, however, are little known, and their value for such purposes until recently was unappreciated.

The recommendations made in this bulletin are based largely on culinary investigations conducted at the Coastal Plain station of the North Carolina Department of Agriculture at Willard, N. C., in a typical farm kitchen. As a wood-burning kitchen range or a standard kerosene stove and ordinary kitchen utensils were used, the results are such as may be expected under home conditions.

Methods of preparing sirups, jellies, unfermented juices, catsups, canned grapes, spiced grapes, conserves, preserves, marmalades, jams, and other products were tested, as well as the shipping qualities of the goods.

REQUIREMENTS FOR SUCCESSFUL WORK

By careful work, desirable food products for the home can be made economically on the farm from surplus Muscadine grapes.

Of the named varieties, the Thomas, generally speaking, makes the best grape juice and sirup of all the varieties tested and ranks near the top in tests of other products. The Scuppernong probably ranks second as a culinary variety. Its skin is more tender than that of the Thomas, and its fragrant aroma and light color combine to make its products distinctive.

Select fruit should be used. All diseased and dirty berries should be culled out.

The ordinary kitchen utensils used in perserving other foods can be employed in preserving grapes. Enamel ware, wooden utensils, and glass containers should be used. Metal ware is subject to the corrosive action of fruit acids. A small homemade grape crusher (fig. 1) is almost indispensable. It is very efficient, though crude, and saves much time and labor. A cider press also is well adapted for crushing and pressing grapes.

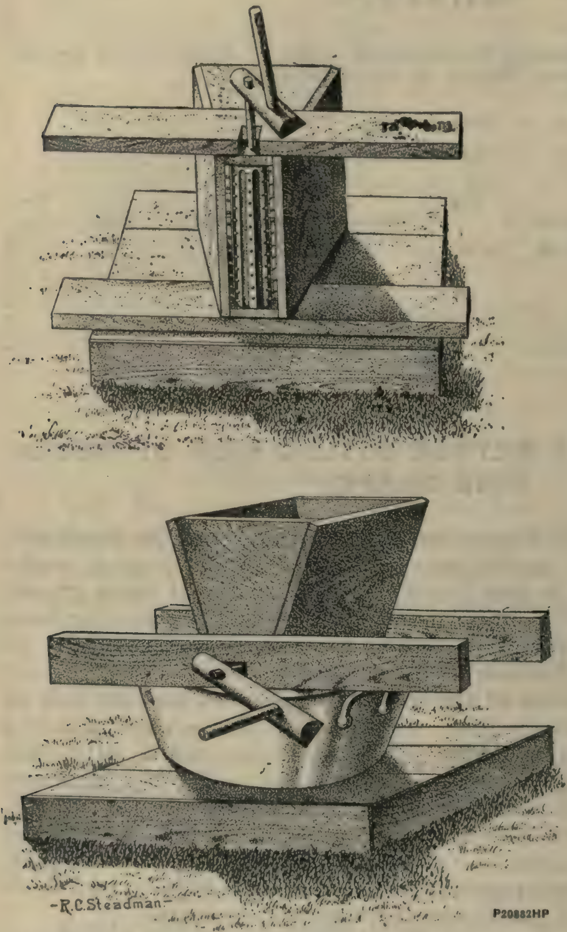

FIG. 1.—An inexpensive homemade grape crusher

Unfermented grape juices, jellies, canned grapes, sirups, and catsups probably are the most desirable home products, taking into consideration quality, expense, and the labor required in their preparation. Preserves, marmalades, and jams require larger quantities of sugar and are difficult to prepare, while the large percentage of sugar they require hardens the skins somewhat, even when the best methods of preparation are used.

MUSCADINE GRAPE PRODUCTS

SIRUP

Since no sugar is used in making it, the sirup is one of the cheapest of the culinary products made from Muscadine grapes. It can be utilized not only as a substitute for sorgo and other sirups but also as a sugar substitute for sweetening unfermented Muscadine grape juice and in making sirup for canning grapes.

Varieties.—The quality of the sirup made from different varieties of Muscadine grapes varies considerably. The varieties having the highest natural sugar content usually make the most delicious and highest quality sirup and also yield the most sirup per gallon of fresh juice. The Scuppernong, Thomas, Luola, Latham, Mish, George, and similar varieties of high quality make the best sirups. The James makes a sirup of fair quality, and the Flowers and Eden varieties make sirups which, relatively speaking, would be called acid and rough.

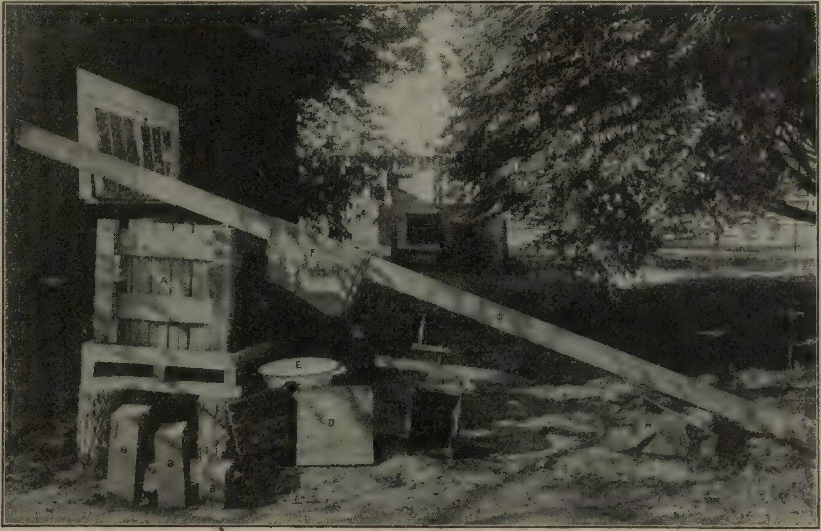

Fig. 2.—A homemade grape crusher and press used in the Muscadine grape-sirup experiments, showing its construction: A, Stationary part of the press; B, press blocks; C, false bottom; D, top, lower surface; E, pan to receive the juice as it flows from the pess; F, pomace bag which holds the crushed grapes while they are being pressed; G,, lever hinged to the building; H, weight to be attached to the outer end of the lever; I, grape crusher

Picking.—In picking grapes for sirup it is important to select only sound, ripe fruit. Green grapes greatly increase the acidity and reduce the quality of the finished product. Rotted or spoiled grapes impart a bitter, disagreeable taste and an unpleasant odor to the sirup.

Directions for sirup making.—Use well-ripened fruit of the sweetest varieties available. Extract all the juice obtainable by crushing and pressing without heating (fig. 2). Remove any sediment that may have accumulated while the grapes were being crushed and pressed by straining the juice through a double thickness of cheesecloth. For every 6 quarts of fresh, strained Muscadine grape juice stir in 2 ounces of powdered calcium carbonate (i. e., carbonate of lime, a low-priced chemical used in sirup making to remove acids). Heat the juice and allow it to boil about eight minutes. It is necessary to use a container at least one-third larger than the volume of juice, in order to prevent the vessel from overflowing when the juice foams up and breaks into a boil. Where a large vessel is not available the juice may be boiled in small quantities. Pour the hot liquid into heated tall glass containers, preferably large-mouthed fruit jars, so as to permit its condition to be observed. Allow the liquid to settle until perfectly clear and cool. It is well to let it stand over night. After the liquid is cool and clear, showing a distinct sediment at the bottom, pour off the clear portion into a cooking vessel, being careful not to pour off any of the sediment. To this clear liquid add one-sixth of a level teaspoonful of calcium carbonate for each 6 quarts of fresh grape juice which it represents.

Complete the process of sirup making by boiling down the clear liquid, using a vessel one-third larger than the volume of the liquid. If necessary, the sirup can be completed in batches. While boiling down the liquid keep the caramel which forms on the inside of the pan wiped off with a wet cloth, so that when the nearly finished product foams up it will not carry scorched caramel into the sirup. Should any scum form during the cooking process remove it with a long-handled milk skimmer. (Fig. 3, I.) Allow the liquid to boil rapidly until nearly done and then more slowly, to avoid scorching. Cook the liquid until it reaches about one-ninth the volume of the fresh grape juice, or until a small portion cooled in a teaspoon on the surface of cold water in a cup shows about the same consistency as maple sirup or thin sorgo sirup.

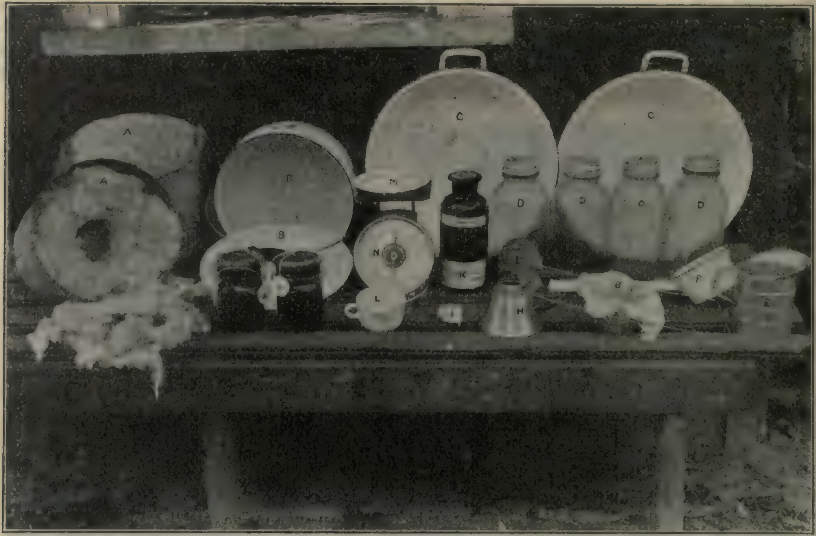

FIG. 3.—Kitchen equipment used in the sirup experiments. The use to which the various utensils were put is as follows: A, Homemade fireless cookers in which the jars of finished sirup were placed while hot for the purpose of making the sirup cool slowly, thus allowing the sediment and added substances to settle to the bottom of the jar; B, a stewpan for heating the sirup jars and for cooking part of the juice the first time; C, dish pans, one for catching the juice at the press and for heating the precipitating jars and the other for cooking most of the juice the first time and for cooking all the juice the second time; D, 2-quart fruit jars (precipitating jars), containers for the juice while clarifying between the first and second cookings; E, a quart cup for measuring the fresh juice, in order to determine the amount of calcium carbonate to be added; F, a dipper for stirring the juice during the first cooking; G, a strainer with cheesecloth for straining the fresh grape juice; H, funnel used while pouring the juice and sirup into jars; I, a long-handled milk skimmer for skimming the boiling sirup; J, a wet cloth for wiping the caramel formation from the inside of the pan while the sirup is boiling down; K, a bottle of calcium carbonate, the cheap chemical used in sirup making; L, a cup of water and a teaspoon for testing the sirup to determine when it is done; M, a saucer in which to weigh the calcium carbonate; and N, scales for weighing the calcium carbonate. The finished product is shown in two glass jars (O)

When the sirup has reached the proper thickness, pour it into heated glass fruit jars, cap the jars, and place them where they will cool very slowly. Slow cooling is very important in making the sirup clear, as it allows all sediment and added substances to settle. This slow cooling can be brought about by standing the jars of sirup in a large vessel of hot water and allowing the whole to cool or, better still, by placing the jars in a fireless cooker. One of these can be made at home by placing waste cotton, such as may be procured from a cotton gin, in a worn-out bucket or box, leaving a place in the center for the jar of hot sirup.

When the sirup has cooled to room temperature it can be stored in a pantry or cellar until desired for use. A small quantity of harmless white sediment, known to chemists as malate and tartrate of lime, will be observed in the bottom of the jars. When desired for use simply pour the clear sirup into the table-sirup stand, leaving the sediment, which is not easily disturbed, behind. Those who prefer, however, can pour off the clear sirup into bottles or fruit jars as soon as it has cooled and then sterilize and seal just as with fruit. Sterilization consists merely in heating the jars of sirup to the boiling point. The filled jars and the caps for sealing them are placed in a pan of water, which is then brought to a boil and held at that point until the contents of the jars are approximately of the same temperature.

Comments and suggestions.—Except where glassware has been recommended it is very desirable to use only granite-ware utensils in handling the grape juice and in making the sirup, for such vessels are easily cleaned. A large granite-ware dish pan (fig. 3, C) is probably the best container to use in boiling the liquid, for it exposes a large surface to the stove and allows rapid evaporation. If preferred, however, a granite-ware wash boiler, preserving kettle, or a large stewpan may be used instead of the dish pan.

Calcium carbonate (carbonate of lime) is used in sirup making for the purpose of removing acids. In the presence of heat it combines chemically with the acids of the grape juice to form compounds which precipitate as sediments or crystallize against the sides of the precipitating jars when the liquid is placed in them to cool after the first boiling. This chemical can generally be obtained from a local drug store, and even if it is not in stock the druggist can order it from a druggists' supply house. There are many natural forms of calcium carbonate of greater or less purity; for example, shells, limestone, marble, marl, and chalk. The commercial forms recommended for use in sirup making are chemically pure calcium carbonate, commercial calcium carbonate, powdered precipitated chalk, and powdered marble dust.

There is also a commercial carbonate of lime used by painters which is known as whiting. This is very cheap, costing approximately 1 cent per pound. Whiting is, however, recommended for use in sirup making only when it can be obtained in the original package in which it was put up by the manufacturer, for in a paint store an opened package is susceptible to contamination by such harmful impurities as white lead and Paris green.

A slight excess of carbonate of lime added to the grape juice in sirup making will do no harm, but generally 2 ounces to each 6 quarts of fresh grape juice will be sufficient to remove the acids. Should the grape juice be relatively high in acid content, however, it would be advisable to add from 2¼ to 2⅓ ounces of carbonate of lime for each 6 quarts of fresh juice before the first boiling.

When the grape juice is first heated it is well to stir it occasionally, but too much stirring seems to increase foaming. As the juice is coming to a boil a heavy foam will form on the surface, rise up, break away, and then subside. As this foam which develops previous to boiling contains free carbonate of lime it should not be skimmed off. The combining of the carbonate of lime with the grape-juice acids gives to the liquid a greenish tinge, which disappears with the precipitation of sediment after the first boiling.

In order to avoid breaking the precipitation jars and also the fruit jars when receiving the finishing sirup, it is necessary to heat them to approximately the temperature of boiling water. This can be done very easily by immersing the jars in hot water.

While it is desirable to allow the liquid to boil rapidly during the cooking process, it is not advisable to remove the lids from the stove in order to have the pan next to the fire, for in this case the heat will be concentrated too much and will scorch the sirup.

It is difficult to describe the stage in the process when the sirup has been boiled down sufficiently, but the sirup maker can easily determine this after one experience. The aim should be to remove the liquid from the stove when it has reached the consistency of a thin sirup. An experienced cook can judge this rather accurately by dropping the liquid from a spoon. The best test, though, is occasionally to take a little sirup in a teaspoon and hold this on the surface of some cold water in a cup, so as to cool it. The cooled sirup in the spoon can then be felt with the finger and its thickness judged.

For keeping Muscadine grape sirup, wide-mouthed fruit jars of pint and quart sizes will be found satisfactory.

In making Muscadine grape sirup the juice of the varieties of grapes mentioned on a foregoing page as being best adapted for sirup will need no sugar; in fact, they should not have sugar added. The sirup of acid varieties like the Flowers and Eden, however, will be improved by the addition of some sugar; say, from one-half to 1 pound for each 6 quarts of juice. The experiments show that the addition of one-half pound of ordinary cane sugar to 6 quarts of Flowers grape juice is equal to the addition of 3 extra quarts of fresh juice of the same variety, in terms of the quantity of sirup produced. The time to add the sugar is just before the second cooking. In this connection attention should be called to the Federal pure-food standards, which require that when a fruit sirup to which sugar has been added is offered for sale in interstate commerce the container must bear a label stating that fact.[1]

A bushel of Muscadine grapes will yield from 2¼ to 4 gallons of fresh juice, depending on the variety. Most varieties, especially those best suited for sirup making, yield over 3 gallons of fresh juice.

In condensing the juice to one-ninth of its original volume to make a sirup of satisfactory consistency, 1 bushel of Muscadine grapes should yield approximately 1⅓ quarts of sirup.

Muscadine grape sirup is considered by many as good as or better than other sirups usually found upon the table.

As Muscadine grape sirup is usually made from home-grown fruit it can be used to supplement or even replace a direct expenditure of money for other sweets.

UNFERMENTED GRAPE JUICE[2]

Where a home supply of Muscadine grapes is available no excuse exists for not utilizing it in making a sufficient supply of unfermented grape juice to meet the family's needs for a year. Unfermented juice is the least expensive product that can be made from grapes, and it is a delightful, refreshing drink for summer use. Muscadine grape juices are successfully preserved by two methods. These are designated as the cold-press method and the hot-press method, because the only essential difference in the two processes is that in one case the juice is obtained by pressing the fresh fruit without heating it, while in the other the fruit is heated and the juice expressed from the hot fruit. The cold-press method is the simplest and quickest and yields brilliant, transparent juices which are not only generally superior in flavor and aroma but also much more pleasing in appearance. The hot-press method yields a greater quantity of juice, but requires the additional labor of heating the fruit before pressing. Again, the hot-press juices resemble more nearly the commercial Concord grape juice, because the heating draws the coloring matter from the skins. Some of these dark juices have a very attractive color, but the flavor which the skins impart to the juice while heating rarely improves the quality of the product. Some of the hot-pressed juices, moreover, are viscid in appearance, whereas by the cold-press method the same variety of grape makes a brilliant, transparent, attractive, and more uniform product. Generally, therefore, the cold-press method is best for home use.

The following directions for making unfermented Muscadine grape juice are based on experiments made by the United States Department of Agriculture in 1916 and followed successfully each year since then in the department's work:

Cold-press method.—Select sound, clean, fully ripe fruit; crush the fruit by hand or, better, with a homemade crusher, such as the one shown in Figure 1. If a cider mill is available it is well adapted for both crushing and pressing.

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[1] Standards of purity for food products. U. S. Dept. Agr., Off. Sec. Circ. 19, 19 pp., 1906.

[2] Charles Dearing. Unfermented grape juice: How to make it in the home. U. S. Dept. Agr., Farmers' Bul. 1075, 31 pp., illus. 1921.

After the berries are crushed the juice should be pressed from the fruit immediately. Small quantities of fruit can be pressed in a clean cloth sack by hand, but if as much as a bushel of grapes is being handled a cider mill or an inexpensive homemade press like that illustrated in Figure 2 should be used. Having obtained the fresh grape juice, strain it through flannel and then place it in bottles or fruit jars. While bottles are suitable if preferred, the quart clamp-top or lightning-seal type of fruit jar is recommended as the best container for grape juice for home use. Such jars ordinarily are more conveniently and successfully used, are more generally available, and can be used also as containers for other products in succeeding years. Having placed the juice in bottles or jars, put these in a water bath and sterilize by heating until the juice has reached a temperature near but not quite up to the boiling point. If a thermometer is available, the temperature can be tested. As soon as the juice has reached a temperature of 190° to 200° F. (95° to 98° C.) remove it from the sterilizer.[3] If no thermometer is available, remove the juice as soon as it shows the first sign of simmering preliminary to boiling. A good home water bath or sterilizer can be provided by placing a false bottom of wire gauze (4 meshes to the square inch) or a thin board in which numerous holes have been bored, in the bottom of a wash boiler or large, covered preserving pot filled with water enough to surround but not cover the bottles or jars of grape juice. (See fig. 4.) The false bottom enables water to get under the juice containers, and the cover of the water bath confines the steam, which sterilizes the upper parts of the containers. Just as soon as the temperature of the juice has reached the point at which sterilization has been assured, remove the bottles containing the juice from the water bath, seal at once, and store in a dark, cool place until desired for use. In using the fruit jars the lids and rubbers are laid loosely on them while in the hot-water bath, so that they also will be sterilized. If bottles are used cork them with new corks that have just been soaked for about 30 minutes in water at a temperature of not less than 140° F. Use a cork a little wider than the mouth of the bottle, and after inserting this as far as possible cut off the rest of the cork even with the mouth. Dry the mouth of the bottle thoroughly and dip in a melted mixture of equal parts of beeswax and rosin or in melted paraffin.

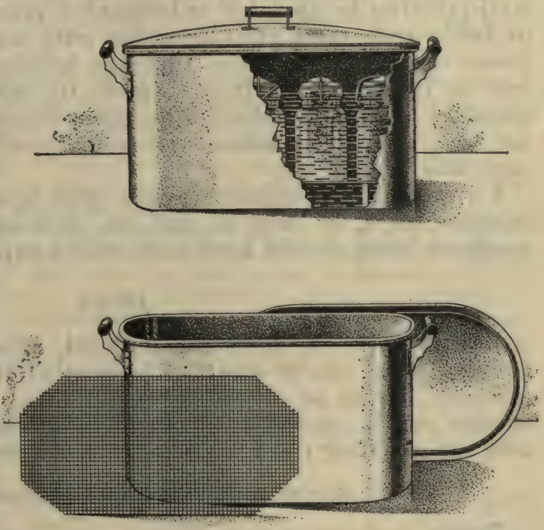

FIG. 4.—An outfit for the home sterilization of unfermented grape juice and other products

Hot-press method.—The hot-press method is identical with the cold-press method, except that the crushed fruit is heated nearly but not quite to the boiling point and is then pressed while hot. In home work the fruit generally is heated in a large dish pan. Stir it while heating, so as to bring the entire mass simultaneously to the desired temperature. Then place it in a cheesecloth bag, hung over a receptacle to catch the juice, and press by hand. Allow the juice to cool, strain it, and then proceed as in the cold-press method.

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[3] It is simpler and quite proper to seal up the juice tightly in bottles or jars, leaving some air space in the container to allow for the expansion of the juices by heating. In this case the containers are submerged and the temperature of the water is taken. The containers, if quart jars, should be left in the water for at least 15 minutes after the water reaches 190° F., but gallon jugs require 30 minutes, while one-fourth-pint bottles take only 5 minutes. The time required for containers of other sizes should be varied accordingly.

The variety of Muscadine grapes used in making unfermented grape juice has great bearing on the quality of the final product. Of all the varieties tried, the Thomas undoubtedly makes the best grape juice. The juice of this variety has the best flavor, the greatest brilliancy and transparency, and the most pleasing and abundant aroma. The Scuppernong variety ranks second for unfermented juice, and the Latham, Mish, Luola, George, Memory, James, and Eden rank above the average.

In the preparation of home products economy may be secondary to quality. This being the case, it is important to mention here that the first or free-run juice obtained in pressing makes the best unfermented grape juice. This is the juice between the skin and the pulp of the berry. It is sweeter, more highly flavored, and more brilliant than the juice from the seed chamber inside the pulp. In home work it is recommended that the juice obtained by a very light, cold pressing be used for unfermented juice making and the residue of hulls, pulp, and pulp juice for jelly making. The unfermented juices of certain varieties that are lacking in body and sweetness can be improved in these respects by stirring into them a small quantity of sugar or Muscadine grape sirup when the juice is opened for use. The exact amount of sirup to add must be determined in each case by tasting.

Unfermented Muscadine grape juice is so very refreshing on hot summer days, so easy to put up, and so inexpensive that every southern home should have a bountiful supply.

JELLY

When proper methods are pursued, Muscadine grapes will yield as fine jelly as can be obtained from other fruits. Certain difficulties, however, are to be overcome, the chief of which are (1) obtaining enough pectin content to give sufficient body to the finished product and (2) avoiding the formation of argol crystals in the jelly.

MEANS OF OBTAINING SUFFICIENT PECTIN

Pectin is the name given to a gelatinous substance occurring in fruits and elsewhere which enables one to make jelly. Pectin occurs in sufficient abundance in such fruits as the apple and currant to make a firm jelly and is very abundant in the white peel of citrus fruits. In some fruits it is lacking almost entirely, so that these fruits are not used for jelly making. In Muscadine grapes it is present, but in quantity generally insufficient for making firm jelly unless methods are followed which augment or concentrate the pectin.

The investigations of the Department of Agriculture show that certain factors bear upon pectin content.

(1) Probably the first consideration is to use fruit at the right stage of maturity. Full-grown green grapes seem to develop the most pectin in jelly making, and the pectin content decreases with the ripening of the fruit. Since flavor and tendency toward crystallization must be considered as well as pectin, the aim should be to use fruit as ripe as possible and yet not so ripe that the pectin will be insufficient to give to the jelly the desired body and texture. For home use riper fruit can be used than in commercial jelly making, but it is well even in home jelly making to have as much body or firmness as possible without sacrificing flavor or texture. All things considered, it probably is best to use fruit in the "rare-ripe" stage for jelly making or to use equal parts of green and ripe fruit.

(2) The pectin content varies considerably with the variety, and it behaves differently in the different varieties as they ripen. Some Muscadine grapes, even when rather green, have very little pectin, whereas others, such as the Scuppernong, not only have abundant pectin when green, but even when ripe have sufficient pectin to make a fair grade of home jelly. Other varieties, for example, the James, have abundant pectin content for home jelly making up to the "rare-ripe" stage, but when fully ripe have lost so much pectin that it must be supplied if jelly is to be made. The Thomas does not have so much pectin as the Scuppernong, but as it ripens it maintains its pectin better than the James variety. The Flowers resembles the Scuppernong in pectin content, and the Mish is similar to the James, whereas the Eden has slightly more pectin than the Thomas.

(3) Having obtained fruit at the proper stage of ripeness of a variety known to contain a relatively large amount of pectin, the next means of insuring a firm jelly is to cook the fruit thoroughly before extracting the juice for jelly making. The cold-pressed juice of Muscadine grapes contains practically no pectin, but by heating the fruit before extracting the juice pectin apparently is liberated into the juice from the solid parts of the berry. Thorough cooking insures the liberation of all the pectin, but, on the other hand, if the cooking is continued too long the volume of juice will be lost through evaporation. Cooking the fruit for approximately 10 minutes after the juice first boils is about right.

(4) Having obtained by cooking and juice extraction a jelly stock containing pectin, the proportion of pectin can be increased by boiling down the jelly stock to decrease its volume or by adding less than the normal quantity of sugar, so that in making the jelly a greater evaporation will take place before the jelling point is reached. It should be remembered, however, that the greater the concentration or the longer the cooking, the darker and less brilliant is the finished product. Moreover, in concentrating pectin by the evaporation of jelly stock, the acid and the sugar content of the jelly stock also are concentrated. It is therefore especially necessary in this case to take precautions to avoid crystallization, and since the fruit sugar is concentrated less commercial sugar need be added. In the experiments of the Department of Agriculture the use of a half measure of sugar to a full measure of Scuppernong jelly stock from "rare-ripe" grapes, or, better, concentrating the normal jelly stock about one-half and then using sugar, measure for measure, gave a very firm jelly.

(5) The final resort in increasing pectin is the introduction of pectin into the jelly from an outside source. The best means of doing this is by using an orange pectin solution, since this is high in pectin and almost free from acidity, color, and flavor.[4]

Since apple-jelly stock contains abundant pectin, it is a convenient substitute for the orange pectin solution. In using it, however, a certain amount of color and flavor will be introduced, and it is less effective than the orange pectin solution in preventing crystal formation. Apple stock made from mild-flavored green or yellow ripe apples is best.

When a pectin solution is added to increase the pectin content, the quantity of sugar used should be based on the quantity of grape-jelly stock, regardless of the quantity of pectin solution added, for the aim is not to make a pectin-solution jelly, but to add pectin to the grape-jelly stock. The use of pectin solutions in making Muscadine grape jelly is entirely practicable and advisable, though not necessary to make jellies of sufficient firmness for home use. Through the use of small quantities of pectin solution not only can firm jellies be made but crystallization is avoided, and higher colors and flavors can be obtained, since riper grapes may be used.

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[4] The following recipe adapted from Extension Bulletin No. 6, Florida State College for Women, Tallahassee, Fla., outlines a quick method of preparing the orange pectin solution: Cut or scrape the yellow from the peel of oranges. Pass the remaining white portion through a food chopper; then weigh it. For each quarter pound of peel add half a pint of water and 2 tablespoonfuls of lemon juice. Mix thoroughly and allow the mixture to stand one hour. Add 1¼ pints of water. Let stand 1 hour; boil 10 minutes; let stand until cold. Place in a flannel jelly bag, press to remove the juice, and drain the juice through a clean flannel jelly bag.

This produces a jelly stock from which clear jelly can be made. It can be prepared in quantity and canned for future use. By double running the white peel of 3 dozen oranges the writer has obtained on two occasions 24 pints of pectin solution. Rough-skinned, light-weight oranges have the most white peel.

The reader is also referred to M. C. Denton, R. Johnstin, and F. W. Yeatman. Home-made apple and citrus pectin extracts and their use in jelly making. U. S. Dept. Agr. Circ. 254, 11 pp. 1923.

PREVENTING CRYSTAL FORMATION

In making grape jelly and when grape juice is heated, the excess acid tends to crystallize, forming potassium acid tartrate, a substance which in wineries, unfermented grape-juice factories, and other grade-product establishments is known as argol. In large establishments this argol is saved and later refined in by-product establishments and sold as cream of tartar and tartaric acid. The formation of argol crystals in jelly should be avoided. These crystals are readily formed in Muscadine grape jellies, owing to the high acid content of this fruit, but with proper precaution crystallization may be avoided. There are several more or less effective means of avoiding the formation of crystal in the jelly, some of which are more important than others.

(1) Grapes ripen in the fall when the nights are cool. It is therefore possible to make the jelly stock[5] in the afternoon and allow it to stand over night in shallow pans without any fermentation. When so treated the jelly stock cools rapidly and crystals form readily against the pan and over the surface of the liquid. The jelly stock is then run through a flannel bag to remove the crystals, and the process of jelly making is continued. By this method crystal formation is greatly reduced, but not entirely prevented. The jelly stock should be allowed to stand until thoroughly cool, but it is very important not to let it stand until fermentation begins.

(2) Another method of removing crystals is to seal the hot jelly stock in glass fruit jars and then to strain and make jelly from it during the winter, at a season when there is more time for special culinary work, after the crystals have formed in the jars. This method has proved valuable, though not infallible, as a means of avoiding crystallization in the jelly. The canning of the jelly juices in glass fruit jars and then making jelly in small quantities as needed avoids crystals and also provides fresh jelly, which is better than old jelly.

(3) Other factors to be considered in avoiding crystallization are as follows: (1) The greener the fruit used, the greater the tendency to crystallization; (2) the higher the acid content in relation to the sugar content of the grape variety used, the greater the tendency to crystallization; and (3) the smaller the proportion of sugar added to a jelly stock, the greater the tendency to crystallization. In regard to these factors, however, a medium ground may be best, since desirable pectin content and a tendency to crystallization are, generally speaking, influenced in opposite directions.

(4) The best means of avoiding crystal formation, a means which at the same time increases the pectin content and permits the making of jelly from fresh jelly stock, is the addition of a small quantity of orange pectin solution, apple jelly stock, or other fruit-pectin solution. In the experiments of the Department of Agriculture the addition of 1 cup (one-half pint) of orange pectin solution and three-fourths of a quart of sugar to a quart of ripe jelly stock was sufficient to prevent crystal formation.

QUALITIES OF VARIETIES

Muscadine varieties differ in the flavor, aroma, and color which they impart to their jellies. Of the named commercial varieties, the

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[5] Jelly stock is the term used to designate the juice obtained after cooking the fruit and placing it in a drip or drain bag. Jelly stock differs from hot-pressed unfermented juice in that it has been heated beyond the boiling point.

Thomas yields the sweetest, mildest jelly, one suited for dessert uses or with bread and butter in school lunches, whereas the Eden and most varieties of *Vitis munsoniana* yield tart jellies, well suited to serving with meats and game. The Thomas jellies have a fragrant aroma and a bright-red color. The Eden and the Munsoniana jellies are somewhat lacking in aroma and very dark in color, but not unattractive. The Scuppernong ranks highest of all varieties from the standpoint of making a jelly which is at once good, attractive, and distinctive. Scuppernong jelly is very fragrant in aroma, a beautiful golden brown in color, and has a delicate flavor. Its flavor is intermediate between the sweet and the tart jellies, so that it is suitable for all occasions. Luola jelly has as fine color and flavor as that of any variety tried, but it is less distinctive. It has somewhat the flavor of Concord grape jelly and is mild and sweet like Thomas jelly. The Flowers makes a jelly inferior in aroma, color, and flavor to jellies of the other varieties mentioned, and the James, Memory, and Mish rank intermediate between Flowers and the best varieties.

The possibilities in blending varieties should be considered. For example, a blend of "rare-ripe" Luola with ripe Thomas (a possibility, owing to their time of ripening) probably would result in a better combination of color, aroma, flavor, and texture than from the use of either separately. By canning the jelly stocks of different varieties, these may be blended with each other and with other fruit-jelly stocks in any desired combination.

DIRECTIONS FOR HOME JELLY MAKING

The investigations of the Department of Agriculture indicate that the best results in home jelly making will be obtained from the following procedure:

Select fruit of a desirable variety and in the proper stage of ripeness, as explained. Use only clean, dry, sound fruit. Avoid fruit picked within 24 hours after rain, and if possible work during clear weather. Stem the grapes by hand and then crush a sufficient number of the berries to provide enough juice in the bottom of the cooking vessel to prevent scorching when the fruit is cooked. The rest of the berries can be crushed more easily after they are hot, using a wooden potato masher. A better plan for crushing, and one strongly recommended, is to crush all the berries before cooking by running them through a homemade crusher, such as the one illustrated in Figure 1. Then cook the crushed berries in a large preserving kettle or a dish pan of a type unaffected by fruit acid, stirring with a long-handled spoon. After they have boiled about 10 minutes, or when the berries are broken down so that the mass stirs freely, pour the cooked grapes into a double cheesecloth bag, or its equivalent, and hang up to drain without pressing (fig. 5). The juice (called stock) obtained in this way can either be canned for use in winter jelly making after crystal formation or used immediately. In either case the process is the same. In making jelly at once, if the nights are cool, so that there is no danger of fermentation, procure the jelly stock in the late afternoon and allow to cool over night in shallow pans, in order to encourage crystal formation. After immediate cooling, after standing over night, or after canning, as the case may be, clarify the jelly stock by running it through flannel or felt at least once. For this purpose a flannel or felt jelly bag (fig. 5) is most convenient. Then test the clarified jelly stock, if possible, for sugar, acid, and pectin, in order that the character of the particular sample may be known and proper measures taken for making the best possible jelly.[6]

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[6] For tests of jelly stock and comments, see next section.

Generally, the tests will show the jelly stock to be such that the following procedure will be approximately correct:

Measure the jelly stock and place it in a cooking vessel of such size and shape that the liquid will be shallow and spread out rather than deep and confined. For each quart of the jelly stock used add 1 cup (one-half pint) of orange pectin solution to avoid crystallization and to increase the pectin content, and then add a level quart measure of cane sugar. Stir to partially dissolve the sugar. Place on the stove and boil steadily without stirring until the liquid jells.[7] Remove from the fire, skim at once, and pour into sterilized jelly glasses; skim again in the glasses if necessary; immediately cover with at least one-eighth inch of hot melted paraffin. When the paraffin has cooled, cap, label, and store the glasses and contents in a cool, dry, dark place.

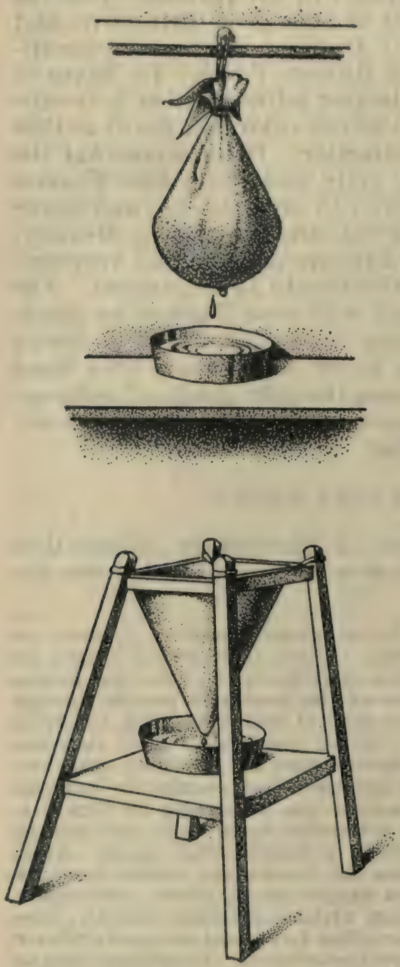

FIG. 5.—A drip or drain bag for use in jelly making (above) and a jelly bag with rack (below)

COMMENTS AND SUGGESTIONS ON THE JELLY-MAKING PROCESS

The following comments and suggestions will aid in the making of Muscadine grape jelly and will supplement and explain the concise directions given in the preceding section:

The acid test.—In making jelly in the home the worker generally will have to rely on the sense of taste as a means of determining the acidity of Muscadine grape jelly stocks, for the test and equipment needed are too complicated for practical home use. If the jelly stock tastes unusually acid for the variety, being made of grapes of the Flowers or some other acid variety, or if relatively green grapes have been used to furnish the jelly stock, it is advisable to add a small quantity of apple jelly stock, or, much better, orange pectin solution. This will tend to prevent the formation of crystals of excess acid in the jelly. A cup (one-half pint) of orange pectin solution or apple jelly stock to each quart of Muscadine grape jelly stock should be sufficient to prevent crystal formation in the jelly. Unless it is necessary to increase the pectin content of the grape jelly stock, the added apple jelly stock or orange pectin solution can be considered as so much grape jelly stock in adding sugar.

The sugar test.—The proper quantity of sugar to add to the jelly stock depends on the proportion of grape sugar already in the fruit and on the abundance of pectin present. The old home rule for adding sugar to jelly stock in jelly making is, "Use measure for measure." This, however, is not always right for making Muscadine grape jelly, in view of the fact that this stock is generally sweeter than other jelly stocks, such, for example, as currant and crab apple. The proportion of sugar in the jelly stock can be determined rather accurately by the use of a saccharimeter (fig. 6), which need not cost more than 75 cents. As the saccharimeter is a valuable instrument for use in many other culinary operations as well as jelly making, it might be considered a necessary piece of kitchen equipment. Those saccharimeters are best which when corrected to standard temperature show the actual percentage of solids in solution. Nearly all the solids in solution in grape juice and jelly stock are sugars. If the saccharimeter test gives a reading of 12 per cent or less, it is safe to use measure for measure, but if the test reads around 17 per cent, as it often does, the proportion of sugar should be reduced to three-quarters of the measure to each measure of jelly stock. If the jelly stock has been shown to be deficient in pectin content by test, the quantity of sugar may be still further decreased in order to allow for concentration. In reducing the sugar, however, it should be remembered that such reduction increases the tendency toward crystallization. It is a better plan to increase the pectin content by the addition of orange pectin solution rather than by the reduction of sugar.

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[7] See description of test to determine the jelling point in the following section.

The pectin test.—The pectin content of a jelly stock can be judged roughly by noting the extent to which the stock tends to flake (i. e., pour in a sheet rather than in separate streams or in one round stream) when poured from a smooth surface, such as the edge of a shallow porcelain pan. The pectin test recommended by Dr. M. N. Straughn and others[8] is easily made by placing a teaspoonful of the jelly stock in a teacup and adding to it a teaspoonful of 95 per cent grain or denatured alcohol. This causes any pectin present to gelatinize. If much pectin is present, it forms in one large mass; if little pectin is present, it forms as individual flakes in the liquid. By making this test it is possible to judge the proportion of sugar to jelly stock to use, and also whether it is necessary to introduce pectin into the stock in order to make jelly of the desired body or texture. "Rare-ripe" Scuppernong grapes generally test sufficiently high in pectin to indicate that a jelly of sufficient body to hold its form when turned out of the glass can be made. This is the ideal texture for home jelly.

Jelly stock from pulp only.—Normally, Muscadine grape jelly is made by cooking the whole fruit, since much pectin can be developed from the skins. Jellies of lighter color and milder flavor, however, can be made by discarding the hulls and making the jelly stock by boiling only the pulps and juice together to develop the necessary pectin in the jelly stock.

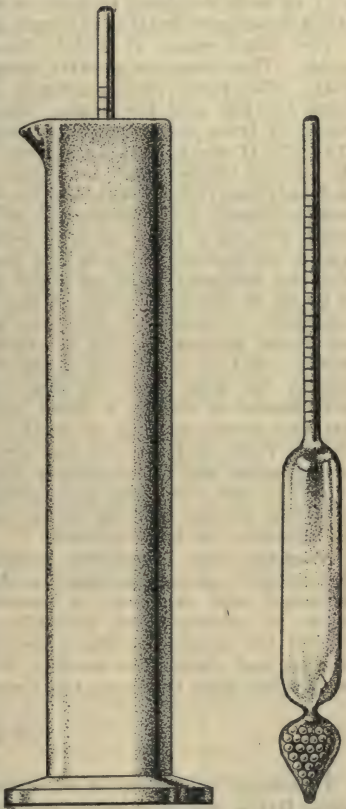

FIG. 6.—An outfit for testing the saccharine content of fruit juices

Time to add sugar.—In making jelly from Muscadine grapes in the home it is recommended that the sugar be added to the jelly stock before beginning the process of boiling down to the jelly point. If, however, the aim is to make the most brilliant and attractive jelly possible, it is advisable to withhold the adding of sugar until the jelly stock has boiled down or evaporated to approximately half its volume. In this case, the sugar should be heated in the oven while the jelly stock is boiling down and added hot, so as not to cool the boiling liquid. This late addition of sugar reduces the time during which the jelly cooks at a high temperature, since the more sugar a liquid contains the higher the temperature required to make it boil, and boiling may proceed at a relatively low temperature up to the time of adding the sugar.

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[8] A. E. Harris. Jellies, preserves, and marmalades. Receipts and directions. Fla. State Coll. Women Extens. Bul. 6, 28 pp., illus. 1916.
Denton, M. C., Johnstin, R., and Yeatman, F. W. Op. cit.

Skimming.—Normally, in making jelly in the home it is well to remove any scum forming on the surface of the boiling jelly as soon as it forms in a definite mass, but skimming is not absolutely necessary until the finished jelly has been poured into the glasses. If a heavy scum forms, it is best to remove it before the jelly foams up in boiling; again, when the boiling is completed but before pouring into the jelly glasses; and then a third time after it is in the glasses. Normally, however, it will be found entirely satisfactory to omit either the first or the second skimming mentioned.

The jelly test.—In making jelly for home use the aim should be to end the boiling-down process as soon as enough water has been evaporated to give a jelly of sufficient body to hold its form when it is turned out of the glass, but to avoid cooking it until it is tough and gummy.

The exact stage at which the jelly should be poured is called the jelling point. This depends greatly upon the pectin content of the particular lot of jelly. The more pectin present the sooner the jelly can be safely removed from the fire and the higher the quality of the jelly. Normally, it should be removed from the heat very shortly after it has attained a temperature of 218° F. If one is making several runs of jelly from the same lot of jelly stock the proper temperature for removing the jelly from the fire can be determined and uniform results obtained by cooking all lots to this temperature. If, however, different jelly stocks are being used, the exact temperature of the jelling point will vary more or less, owing to the variable pectin content. For this reason in making jelly in the home the thermometer serves only as a guide, and the ordinary flake or sheet test should be relied upon chiefly. This test is made by taking a little of the boiling liquid on a stirring paddle or spoon, rotating it a moment to partially cool it, and then pouring it back into the cooking vessel, noting the way in which it leaves the paddle or spoon. If it flakes or sheets—that is, pours in a sheet rather than as a thin sirup—it is safe to remove the jelly from the heat. If in pouring over the edge of a spoon the jelly flakes or sheets, a little jelly often adheres to the spoon, hanging as a jellylike string or rope of one-half to 1½ inches in length. After making one or two runs of jelly, the worker will have little difficulty in determining the jelling point fairly accurately by the flaking or sheeting test. The time required to boil down the jelly stock and sugar mixture to a jelly varies greatly with the volume of jelly being made, the shape of the cooking container, and the intensity of heat applied.

Weeping.—The Muscadine jellies, like other jellies, tend to "weep"; that is, they tend to absorb moisture and by capillary action climb up the side of the container and overflow in tearlike streams. No means of avoiding this is known at present; but, normally, weeping will be avoided if the worker does not fill the glasses to the brim, is careful not to tilt or jar the jelly in the glasses, and stores the product in a dry place. There are commercial devices for sealing jelly tumblers tight enough to prevent weeping.

CANNED GRAPES

Canning is a very economical way of utilizing Muscadine grapes, since little sugar is required for this process. The canned grapes are suitable for serving on the home table in sauce dishes as a breakfast appetizer, a side dish, or a dessert. They can be used also in pies, puddings, cakes, etc.

In the investigations of the Department of Agriculture the Muscadine grapes were canned successfully by three methods, designated as the cooking method, the sugar-sirup method, and the grape-sirup method. The first is the easiest and most practicable, whereas the two others have the advantage of yielding more attractive products, because the berries do not lose their shape. Whatever the method, the essential features are (1) getting rid of the seeds, (2) softening the skins, (3) sweetening with a small addition of sugar, and (4) careful sterilization and sealing in fruit jars.

Cooking method.—In canning grapes by the cooking method, which is the one generally recommended for home use, use firm but fully ripe fruit. After weighing the berries, separate the skins and pulps after running the fruit through a crusher like that shown in Figure 1. If preferred, the berries may be pulped by hand. Then place the hulls in a closed vessel, adding one-half pint of water for each 6 pounds of fresh fruit. Cook until the hulls are quite tender. When this point is reached, the added water will have mostly evaporated unless the vessel has been very tightly closed. While softening the hulls, heat the pulps and juice in another vessel until the pulps break down enough to liberate the seeds. Then put the pulp through a colander to get rid of the seeds. Put the seedless pulps and softened hulls together when cool and add sugar and water at the rate of 1 pound of sugar and one-quarter pint of water to each 6 pounds of fresh fruit. Then bring the mixture slowly to a boil, and after boiling for 8 to 10 minutes pack and seal it while hot in hot sterilized fruit jars.

Sugar-sirup method.—In canning the whole berries by the sugar-sirup method use firm, ripe fruit. Slit all the berries on the side horizontally with a small-bladed knife, and then brush the seeds from them with the point of the knife. Pack the seeded whole berries, cold, in pint jars and pour over the fruit until the jars are filled a sugar sirup made by boiling equal measures of sugar and water together for 1 minute. After allowing to stand for 30 minutes to permit the sirup to seep through the slit in the berries, refill the jars with sirup, and put the rubbers and caps in place with the jar clamp in a raised position. Then steam the jars in a home steamer until the skins have softened and the fruit and jars are sterilized. While the jars are still hot refill with boiling sugar sirup and then seal by clamping down the lid. The proper length of time to steam the fruit and jars varies with the variety. The Scuppernong requires approximately an hour; the James should steam 1½ hours; and the Thomas will require fully 2 hours. The aim should be to steam the fruit long enough to soften the skins without having the berries break down. Unless the seeds are removed so that the sugar sirup gets inside as well as outside, the berries shrivel up when canned by this process.

Grape-sirup method.—The grape-sirup method is identical with the sugar-sirup method, except that a concentrated grape juice, made by boiling the unfermented fresh juice down to two-thirds its original volume, is used. The quality of the finished product obtained by this method is hardly equal to the product canned in sugar sirup, but the method avoids the necessity of using sugar and therefore is economical.

For canning purposes the Thomas and the Scuppernong varieties are best.

SPICED GRAPES

Spiced Muscadine grapes are much the same as canned grapes prepared by the cooking method, except for the spices. The product is slightly more expensive and more difficult to make, but a small quantity of it will be desirable for the sake of variety, and many people greatly prefer the spicy products to those having pure fruit flavors.

The method used for making spiced grapes is essentially like the cooking method of canning the grapes.

After combining the softened hulls and seeded pulps, for every 5 pounds of fresh fruit used add the following:

2½ pounds of sugar.
2 ounces of ground cinnamon.
1½ ounces of ground cloves.
½ pint of vinegar.

Then boil the mixture over a slow fire until a little thick. If 5 pounds of fruit are used this will require about an hour's boiling.

Since the flavor of the spices predominates, the variety factor is of less importance than in other products. Some people prefer a special product made as above, but with the vinegar, the cloves, and half the sugar omitted. Again, just the grape skins may be spiced, leaving the pulp and juice for marmalade making.

CATSUP

Muscadine grape catsup is a pleasing sauce to serve with cold meats. It is a cheap product, easily made, and keeps well even in an open container. Moreover, it holds an important place in Muscadine grape utilization, because it can be made from varieties which, owing to their acidity, are not well adapted for use in other ways. In making catsup the juicy varieties are best, and an acid juicy variety is to be preferred to a very sweet one.

To make Muscadine grape catsup, first weigh and then crush the fruit. Stew the crushed fruit over a slow fire until soft, and then work it through a colander with a spoon, leaving the skins and seeds behind. To the juicy portion which passes through the colander add for each 5 pounds of fresh fruit used—

2½ pounds of sugar.
1 tablespoonful of ground cinnamon.
1 tablespoonful of ground allspice.
1 tablespoonful of ground cloves.
½ tablespoonful of pepper.
½ tablespoonful of salt.
1 pint of vinegar.

Boil the mixture until slightly thick and then seal it hot in hot sterilized bottles or fruit jars.

CONSERVES

Muscadine grape conserves are delicious products, well adapted for use in making sandwiches for school lunches. They also make a good dessert and may be used as a substitute for preserves, jam, etc. They are slightly more expensive than some of the products already described, but if orange pectin solution has been prepared in connection with jelly making, the making of these conserves will utilize the oranges from which the peel was taken for the pectin solution. The fact that they contain raisins, oranges, and nuts in addition to grapes makes them a very wholesome combination. One recipe for making conserves is as follows:

3 pounds of grapes.
1 pound of sugar.
½ pound of finely ground raisins.
2 large oranges.
½ pound of finely ground pecans.

Take sound, ripe grapes. Weigh and pulp them. Treat the pulps as in canning, in order to remove the seeds. Grind the hulls fine in a meat grinder or chop them fine, and then soften them as in canning. Place the hulls and pulps together and add for every 3 pounds of fresh fruit 1 scant pound of sugar, half a pound of finely ground raisins, the meaty part of two large California oranges, and one-fifth of the ground peel of one orange. Cook this mixture approximately an hour over an even, slow fire until it is real thick. Then stir into the mixture one-half pound of ground pecan-nut meats. After again allowing it to boil for about 5 minutes remove it from the fire, pack solidly in small containers, such as 4-ounce jars or jelly glasses, and cover with paraffin. If the product is packed in jars, these can be processed for 15 minutes, in order to sterilize the contents.

Since the conserves are a mixture of several products, the particular variety of grape used is of less importance than in some other products. However, those varieties having relatively thick skins which soften readily are the best for this purpose. Delicious conserves have been made from the Scuppernong, Thomas, and James varieties.

PRESERVES

Muscadine grapes can be used for making preserves, but they are not as valuable in this form as in products requiring less sugar.

The large quantity of sugar used in preserving causes the skins of the grapes to harden more or less, even though they have been thoroughly softened during the process of preparing the preserves.

The method which was found best for preserving the grapes is as follows:

Take "rare-ripe" fruit. Weigh it and slit the berries on the side or cut in two with a sharp knife and extract the seeds with the point of the knife. To every 2 pounds of grapes add a half pint of water and cook the fruit in a closed preserving kettle until the skins are tender. When this point is reached add 1½ pounds of sugar for every 2 pounds of fresh grapes after it has been brought to approximately the same temperature as the fruit by heating in the oven. Then allow the mixture to boil slowly for approximately five minutes, after which lift the berries from the sirup with a long-handled, perforated milk skimmer, and place in shallow dishes. Boil the sirup about five minutes longer in order to thicken it to near but not quite the point of concentration at which it should jell. Then remove it from the fire and pour over the berries. Allow the berries and sirup to stand over night. The next morning pack the mixture, while cold, into fruit jars. Process these by heating in a home steamer for a sufficient time to sterilize the jars and their contents thoroughly, after which clamp the jars tight and label them. Pint jars require processing for about 20 minutes and quart jars require about 30 minutes.

Generally speaking, the varieties which are suitable for canning purposes are the ones best adapted to preserving.

JAM

Muscadine grape jam is a very good product if properly made, but there is danger of too much or too rapid cooking, of the use of too much sugar, and of not getting the skins properly softened in so sweet a product.

Up to the point of adding sugar, jam is prepared in the same manner as canned grapes. Then to the combined hulls, pulp, and juice—the skins having been softened and the seeds removed from the pulp—1 pound of sugar is added for each 2 pounds of fresh fruit. The mixture is cooked very slowly, with frequent stirring, until thick, then packed and sealed hot in sterilized jars.

If sweet varieties of grapes are used, less sugar is needed, while if the varieties are acid, the proportion of sugar had better be increased. The Flowers grape, a very coarse variety, makes a good jam by using 3 pounds of sugar to 5 pounds of fruit. Although not so well adapted for use in other ways, this is one of the best varieties for jam making, because its skin is meaty and readily softened. The relative softening qualities of grape skins may be determined by biting the skin and noting the ease with which it parts under the pressure of the teeth. Such varieties as the Thomas and James offer more resistance to the teeth than varieties like the Flowers and Scuppernong.

MARMALADE

Of the heavily sugared Muscadine grape products, the marmalade is most desirable.

To make this product, pulp the ripe grapes, discarding the skins. Heat the pulps with the juice and put them through a colander to remove the seeds. Add to the pulp and juice half a pound of sugar for every pound of fresh fruit used, or, better, one-half quart of sugar per quart of grape pulp and juice. Cook the mixture slowly on a steady fire for approximately an hour, or until thick and of jellylike consistency. Stir repeatedly while it is cooking. If desired, ground pecan-nut meats, strips of citrus fruits, or a few softened grape hulls may be added to the mixture about five minutes before removing from the stove. Pack and seal the marmalade hot in sterilized jars.

FRUIT BUTTER

A good fruit butter can be made by following the directions for marmalade except that only one-eighth pound of sugar to a pound of fresh fruit is used.

MINCEMEAT SUBSTITUTE

Muscadine grape mincemeat substitute is another appetizing and distinctive product, somewhat like conserves, but cheaper, and containing fewer ingredients. No oranges are required in making this product. This is an important consideration, since oranges are expensive and often very scarce in parts of the Muscadine grape territory at the time the grapes are ripening. This preparation, as its name implies, is a substitute for ordinary mincemeat. In making pies equal parts of the mincemeat substitute and chopped apples are usually used, but the substitute is delicious without the addition of apples.

To make the mincemeat substitute, pulp the grapes, placing the pulp in one porcelain vessel and the hulls in another. Cover the hulls with water, boil violently until tender, and then run through a meat grinder, using the coarsest plate. To the pulp and juice add a teacup of water (one-half pint) for every quart of pulp and juice; boil until tender (about 15 minutes), and press through a colander to eliminate the seeds. Then mix the pulp, juice, and hulls, and to every quart of the mixture add—

The pulp of one lemon.
The ground white rind of one lemon.
Two cups (1 pint) of sugar.
One grated nutmeg.

Boil until of a thick, smooth consistency—that is, until it flakes or sheets when poured from a spoon. Seal while hot in sterilized jars.

In using this product for pies add one part of chopped apples for each part of grape mincemeat substitute, or, where fall apples are available, these can be added when making the substitute.

FLAVORING SIRUP

This sirup, as its name implies, is intended for use as a flavoring ingredient in the making of punch, sherbets, ices, etc. It is quite different from the heavy concentrated product previously described.

To make the flavoring sirup[9] add 1 quart of water to each gallon of crushed grapes and boil violently until thoroughly cooked—that is, until easily stirred and of even consistency—the berries being broken down. Then pour this liquid into a thick flannel jelly bag and let it drip into a porcelain vessel until all available juice is secured. Measure the juice and return it to the preserving kettle, adding a measure of sugar for each measure of juice. Stir until the sugar is dissolved. Let it reach the boiling point, but it must not boil or bubble. As soon as the boiling point is reached pour the sirup into sterilized bottles or jars and seal them while hot.

Two to three tablespoonfuls of this flavoring sirup added to a glass of water or to crushed ice is very refreshing.

For punch, use 1 pint of the flavoring sirup to each gallon of material.

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[9] This recipe was furnished by Mrs. Dora Dee Walker, formerly assistant State home demonstration agent, Appleton, S. C., now food conservation specialist, Rock Hill, S. C.

PASTES

Fruit products, such as jams, preserves, jellies, and other forms, some of which have not been used generally in this country heretofore, have been made in recent years to an increasing extent as a means of utilizing surplus fruit. Among these, none are more deserving of attention than the fruit pastes. Though comparatively little known here, the making of fruit pastes or products similar to them has been practiced for many generations, particularly in some parts of the Old World.

In many tropical countries paste is one of the chief forms in which surplus fruits are conserved for future use. A common practice in such places is to use cheese with fruit pastes, the combination serving much the same purpose as a salad course in the United States. This combination of paste with cheese, and especially with cottage cheese, is used either as a salad or a dessert.

Fruit pastes are not only wholesome and delicious but economical, because they do not require excessive quantities of sugar. Like the fruits from which they are made, they provide the body with substances needed to keep it in health, and for this and other reasons are often considered more wholesome for children than candies made chiefly of sugar. The use of fruit pastes as a substitute for candies and other confections rich in sugar has much to commend it. Further, the paste can be made with sugar substitutes, such as Muscadine grape sirup, corn sirup, homemade cane sirup, and low-grade sugar, instead of high-grade pulverized sugar.

Among the pastes none is more attractive than that made from Muscadine grapes. The use of these grapes in combination with other fruits for paste making generally results in an improved product. It is entirely practicable and advisable to use the same grapes for preparing Muscadine grape juice, jelly, and paste.

MUSCADINE GRAPE PASTE MAKING

The process of making Muscadine grape paste is quite simple, but certain factors must be considered in order to make a desirable product. The main steps in paste making are (1) the procuring of suitable fruit, (2) the separation of the pulpy portion of the fruit from the juice, seeds, and skins, (3) the addition of the proper quantity of sweetening, (4) the cooking of the paste until it is at the right degree of stiffness or concentration, and (5) the drying of the product.

THE VARIETY TO USE

The question of variety of Muscadine grapes for paste making is not so important as in making grape juice and jellies. Nevertheless, it is important to use the varieties which will make a paste of the desired quality. Generally speaking, those varieties which have the meatiest pulps are most desirable, since such pulps have the ideal proportion of moisture to dry matter; such varieties also yield a larger quantity of pulp from a given measure of fruit.

There is some variation in the flavor of pastes made from different varieties. Those of high sugar content, such as the Thomas, yield the best and highest flavored pastes. Varieties which owing to their pectin content are most desirable for jelly making will make a product with the most attractive appearance, because of the fact that the paste of such varieties when equally and sufficiently firm will be more nearly transparent.

The color of the finished products may be influenced greatly through the choice of varieties. For example, the James makes the darkest paste of any of the standard varieties, a very dark brown in color. The Flowers makes a very attractive light-yellow paste of approximately the same color as apple paste. The Thomas makes a light-brown paste intermediate in shade between that of the Flowers and the James, whereas the Eden paste is a little darker than that of the Thomas. The Scuppernong variety, because of its light color and high pectin (the jelly-making substance) content, makes a light paste, resembling somewhat that of the Flowers, but having a more greenish tinge and a more jellylike consistency.

One should also consider the acidity and sweetness of the fruit and its general condition. The grapes used in paste making should be sound and fresh, fully ripe, but not overripe. The fruit of varieties of high acid content, of course, makes pastes which are sprightly as compared with the product of varieties having a low acid content. The wild Muscadine grapes for this reason make a more acid paste than most of the cultivated varieties; in fact, a slight additional quantity of sugar or sirup is advisable when their pulp is used. The pulp of sweet varieties needs less sweetening. It apparently makes little difference in the finished product whether the pulp for paste making is procured from the whole fresh fruit or as a by-product from the making of jelly or other grape products.

It is of importance to use freshly harvested fruit for paste making. Fruit that has been standing for some time, especially in large containers, may have broken and slightly fermented berries among the sound fruit. These will cause a discoloration of the pulp, for in the process of fermenting the color in the skin is set free.

METHODS OF OBTAINING PULP

Pulp from fresh fruit.—Pulp from fresh fruit is obtained by crushing the grapes and separating the pulp from the skins and juice. This can be done most effectively by using a small homemade hand crusher, such as is illustrated in Figure 1, then picking out the skins and draining off the juice. The pulps should then be heated, with sufficient stirring to prevent their sticking to the cooking vessel, until they appear white and full of air bubbles. When they have reached this stage, they will readily break on being pressed slightly between the fingers. They should then be worked through a potato ricer or colander, for the purpose of separating the pulp from the seeds. Pulp obtained in this manner may be used at once for paste making, or it may be canned in glass containers for use at any time during the winter.

Canning the pulp.—When canning the pulp the jars should be filled only to the neck, for the pulp expands on heating. The jars should be heated in a water bath (as recommended on page 7) until the pulp within the jars reaches the temperature of 180° F., when the jar should be sealed at once. If a thermometer is not available, allow the quart jars of pulp to remain in the bath for one hour after the boiling point is reached, the boiling to be continued during this time.

In preparing the pulp from fresh fruit in this manner, a variable quantity of water will be combined with it, depending upon how much moisture is contained in the seed cavities. Very juicy varieties will yield a moister pulp than those with less juice; the pulp of the latter is more desirable. If the pulp from juicy varieties seems entirely too moist, it should be placed in a double cheesecloth bag and squeezed by hand sufficiently to remove a part of the moisture. One of the chief causes of failure in making Muscadine grape paste is due to the fact that consideration is not given to this matter of moisture content in the pulp used. A certain proportion of moisture in the pulp is necessary, but if too much is present, a caramel rather than a paste will result. The thrifty housewife will invariably use for her paste the pulp obtained as a by-product when making other products.

If unfermented grape juice is being prepared from Muscadine grapes, it is an easy matter to procure the pulp necessary for paste making as a by-product from the grape-juice operations. After squeezing the juice from the grapes in the farm press, as recommended on page 3 there is left in the press the pomace, or "cheese," which consists of the skins, pulps, and seeds. The pulps can be readily picked from this cheese by children. By heating until it appears white and full of air bubbles and then putting it through a colander or similar utensil, the pulp is separated from the seeds. Pulp obtained in this manner will not be satisfactory unless the grapes used in the press were clean and sound.

The best means of obtaining the pulp is, perhaps, as a by-product of jelly-making.[10] The pulp and juice are boiled for a short time in order to dissolve the pectin from the pulp into the juice so that the latter will make jelly. The mixture of juice and pulp is then hung in a drain bag made of double cheesecloth. After the juice for jelly making has drained out, the pulp and seeds are left. Without further cooking, this mass can be put through a ricer, colander, or similar utensil in order to remove the seeds. It is then in just the right condition for paste making.

Low-quality paste.—A pulp of inferior quality but suitable for paste making may be procured easily by merely stewing the fruit or pomace until it is broken down thoroughly, putting it through a ricer or colander, and hanging up in a double cheesecloth bag the soft, pulpy, juicy portion that goes through the ricer, so that the excess moisture will drain off.

If a fruit, wine, and jelly press is available, pulp for paste may be procured quickly by grinding the fruit through this machine and hanging the pulp and juice which is delivered, separate from the skins and seeds, in a double cheesecloth bag, to allow the excess juice to drain off.

Pulp obtained by stewing the fruit or by use of the fruit, wine, and jelly press will make paste that is more or less reddish, depending on the amount of color in the skins of the grapes used. Such paste is not transparent. It is of value, however, from the standpoint of providing variety in the product.

High-quality paste.—If it is desired to make paste of high quality, in addition merely to separating the seeds from the pulp it is best to work the pulp through a purée strainer in order to remove the coarser portions, the "brushes," which are the bundles of fibers connecting the seeds in the berry with the stem of the grape clusters. With most bunch grapes and some of the Muscadines, these bundles remain with the stem when the grape is pulled from its point of attachment, but in nearly all Muscadine varieties the brush remains with the berry rather than with the stem when they are separated.

If the grape pulp is to be used with other fruit pulps in paste making, the combination should be made before proceeding further.

SWEETENING

The best kind of sweetening to use in making Muscadine grape and other pastes is powdered, pulverized, or confectioners' sugar. This gives a product with the smoothest finish and is preferable to liquid sweeteners, such as sirups, owing to the fact that less cooking is required in order to drive off the moisture and that the paste is, accordingly, lighter in color and more attractive in appearance.

However, other sweeteners can be used satisfactorily. Perhaps the best of these is Muscadine grape sirup, made in accordance with the directions given on page 3. Commercial corn sirup, especially the light-colored type, may be used successfully. Grade C sugar may be used also. If the housewife has homemade sugar from cane sirup, it may be used for paste making, though it is not so good as grade C sugar, since it has more flavor of its own. Ordinary granulated sugar is not recommended, though it can be used. Ribbon-cane sirup has not enough welding power to be satisfactory.

If a solid sweetener, such as powdered sugar, is used, the best proportion for Muscadine grape paste making, when economy and quality of the finished product are considered, is one-half pound of sugar for each pound (or pint) of pulp. If the pulp is drier than the average, it is desirable to use a slightly increased quantity of sugar. Less sugar in proportion to the pulp is required than would be called for in making paste of such a fruit as the apple, which needs more sugar than the grape in order to produce a pasty consistency rather than an apple sauce. If economy in sugar is not a factor and the product is not to be stored, a better flavored paste can be made by using three-quarters to a pound of sugar with each pound of grape pulp. Such pastes, however, are generally too soft to keep well when stored. When using a liquid sweetener in paste making, a pint of sirup may be considered equivalent to a pound of powdered sugar. It is preferable, however, to use it in the proportion of 1 cup of sirup to 2 cups of grape pulp. A darker product results when liquid sweeteners are used, owing to the longer cooking period required.

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[10] The making of jelly from the pulp and juice of the grape after discarding the skins has been shown by the writer of this bulletin to be desirable as an easy and sure means of avoiding argol crystal formation (irregularly shaped acid crystals) in Muscadine grape jelly.

COOKING

In cooking the paste, generally speaking, the same principles are involved as in jelly making. It is better to use milk pans of such size that the paste can be spread out in a thin layer rather than to cook it in a deep vessel like a saucepan or preserving kettle. By using milk pans the moisture is driven off with the greatest possible speed and this tends to make a bright, attractive product. The necessity for a broad-bottomed vessel is greater where a liquid sweetener is used.

Although it is important to drive off the moisture as rapidly as possible, there is, on the other hand, a limit to the speed at which the paste can be cooked. If boiled too rapidly, it sputters and pops out of the vessel and may burn seriously the one who is attending to the cooking. To prevent this it is necessary, especially when the paste reaches the finishing point, to cook it over an asbestos plate or mat. This mat is not so important on an ordinary kitchen range as it is for a gas or oil stove, for on a range burning coal or wood the paste can be drawn back from the hottest part of the stove. Although the paste does not require rapid stirring, it needs almost constant attention, especially as it nears the finishing point. It should be stirred systematically to prevent its burning, and for this purpose a wooden paddle having a square edge is decidedly better than a spoon. The paste should be cooked until it is so stiff that when the paddle is drawn through it the mass will not readily flow together again. Another way to describe the finishing point would be to say that the paste should be cooked until it forms a rather definite mass which can be shoved from place to place about the cooking vessel with the paddle instead of flowing. When it has reached this stage, it should be poured out promptly.

DRYING, CUTTING, AND STORING

Owing to the stiffness of the paste it is important that it be poured out rapidly, and that as soon as it is emptied from the cooking vessel it be placed in a mold or spread into a sheet one-half inch in thickness on a marble, enamel, or china surface. Large meat platters, enameled biscuit pans, the bottoms of enameled dish pans if clean, or a marble-topped table are satisfactory surfaces on which to spread it. These should be oiled or greased and ready to receive the paste when it is done. The best grade of oils, those having the least flavor, are most suitable, though for home use lower grade oils, butter, or even a good grade of lard may be used. After being poured out and spread in a layer approximately half an inch in thickness, the paste should be put in an airy but shaded place, such as an open, shaded window, in order that it may dry as rapidly as possible. If it is set in a sunny window there may be sufficient heat to keep the paste soft. While drying, it should be protected from flies by cheesecloth or netting. It should stand at least 12 hours before it is cut.

Cutting the paste.—After having become reasonably dry, the paste may be cut into small pieces. Portions 1 inch square make a convenient size; it is desirable, however, to cut it in various attractive shapes. The individual pieces of paste should then be rolled in granulated sugar and spread out to dry further. It is well to place them at this time with the side up that was next to the surface on which the paste was originally spread. If necessary in order to get the paste thoroughly dry, it may be left for several days, the pieces being turned occasionally.

Drying the paste.—At times, in the southeastern part of the United States where Muscadine grapes are grown, there is so much moisture in the air that the paste, instead of drying, will actually take moisture from the air. Such periods can usually be avoided, and for home use it is possible to avoid this by canning the pulp and making the paste fresh whenever it is desired and the weather is favorable. This method has another advantage in that sugar is more abundant and cheaper at some seasons than at others. Again, the difficulty in drying paste owing to weather conditions may be overcome by dipping the pieces of paste in a candy coating without waiting for thorough drying. The use of heat for drying is not practicable, as heat softens the paste. The use of an electric fan under the weather conditions described will merely increase the trouble unless provision is first made for drying and cooling the air to be blown over the paste. It is useless to store paste that is not thoroughly dry; but after it is properly dried it may be kept indefinitely in boxes or other suitable containers. The box in which the paste is to be packed should be lined with oiled paper, and a sheet of this paper should be placed between every two layers of the paste. If the paste is to be kept over a long period it should be put in the driest possible place and the box sealed to keep out moisture.

VARIATIONS IN PRODUCT

The foregoing directions are applicable for making a plain Muscadine grape paste. They may be varied more or less for the purpose of having variety in the products. For example, if paste is made from several varieties of grapes, and pieces of these pastes are served together from the same dish, pleasing color differences will be obtained. The variation in color may be still further increased by serving the grape paste with other fruit pastes.

Coloring the paste.—Still further variety may be obtained by using harmless vegetable coloring, which may be added to a small portion of the paste when it is about two-thirds cooked. While the rest of the paste is coming to the finishing point this part should be worked thoroughly with a spoon, in order to get the coloring matter uniformly mixed with it. Near the end of the cooking process the colored portion should be added to that in the cooking vessel and worked in uniformly by stirring.

Fruit or nut additions.—Just before removing the paste from the stove various mixtures of nuts and raisins may be stirred into it for the purpose of procuring variety in the product. With the same object in view, it is desirable at times to place the kernels of nuts or such fruits as candied cherries or raisins on the paste immediately after it is poured out, pushing these garnishings into the mass sufficiently to make them hold firmly as it cools. After cooling, the paste is cut around the garnishing so that each piece has in its center a nut kernel or fruit meat. This makes very attractive paste.

Cutting different shapes.—It adds greatly to the appearance of a dish of finished paste if the pieces are cut into various shapes. It is easy to cut the paste into squares, triangles, diamonds, circles, stars, rings, moons, and various other forms.

Making a paste loaf.—Another good method of preparation is to spread on the cooled paste a mixture of ground nuts and raisins or melted marshmallow, or a combination of the two, and then roll the paste into a loaf, cutting it as one would cut a jelly roll. In cutting this candy loaf it is advisable to use a sharp butcher knife, which should be heated and oiled frequently in order that the cleavages may be smoothly and easily made.

Marshmallow layer paste.—It is also possible to spread paste of one color upon that of another and to cut through the double layer so that each piece will show paste of two colors. It is even more attractive to place between these layers of paste a layer of marshmallow whip or melted marshmallow, since the color of the paste is set off better by the white of the marshmallow layer than when the layers of paste are next to each other. For the white layer it is desirable to use the best grade of marshmallows. These should be melted in a double boiler or cereal cooker. It is best to arrange the work so that the paste can be cut in the desired form immediately after placing the marshmallow between the layers, for at times the marshmallow, when it cools, hardens to such an extent that it is difficult to cut it without causing it to pull out in shreds from between the layers. This trouble is especially likely to occur if a poor grade of marshmallows is used.

Paste for sandwiches.—If the paste is cooked only two-thirds of the normal time and is then sealed hot in sterilized jars, it is excellent for use as a filling for sandwiches.

Pulled paste.—If, in making paste, one has used fruit pulp that is entirely too moist, the resulting product, as previously stated, will be a caramel rather than a paste. Should it be noticed that this mistake has been made, the product can be poured out before it has begun to harden, and it can then be pulled, like molasses candy. This makes a very good product and will prevent waste.

Paste in molds.—Again, the paste may be worked into a large solid mold instead of being cut into small pieces. In these molds paste of another color, or even jelly, may be embedded. A butter mold or some homemade form may be used, or even a candy box with top and bottom discarded. A mold measuring 2 by 6 inches is a desirable size; if preferred, these molds may be made of such a size that two of them will pack snugly in a 2-pound candy box. Each mold should be wrapped in oiled paper after drying and before being put into the boxes. The boxes should be sealed by pasting a tape around them where the lid and bottom meet and then stored in a cool, dry place. The mold form is preferable for serving with cheese.

Candy-coated paste.—This is most attractive and delicious and enables one to obtain still greater variations in the product. This coating may be plain or flavored with chocolate, extracts, etc. The addition of chocolate or cocoa will make a brown product, and by the use of harmless vegetable coloring in the candy coating many other attractive colors may be obtained. A plain candy coating will be white, and if used sparingly on pieces of paste the garnishing will show through the coating in a way to tempt the most fastidious appetite.

Commercial candy makers have their own methods of candy coating. The following brief directions are intended for use in the home: A delicious plain candy coating is made by using 2 cups of granulated sugar and 1 cup of cream. Mix and heat thoroughly. Boil until it reaches 230° F. or until a small amount poured on a saucer and stirred with a fork will candy on the fork. Remove from the fire and cool to 110° F. and beat thoroughly; pour into a cereal cooker having boiling water in the lower chamber, so that the candy will not harden. Then dip the pieces of paste into the candy. Thoroughly coat each piece of paste and then place it on an oiled china, porcelain, or marble surface, making sure that the pieces are completely but not excessively coated. After allowing the candy coating to harden, the paste is ready for packing or serving.

In making the plain coating, water or milk may be used in lieu of cream, but it is not so good. The use of a level tablespoonful of butter with the milk is about equivalent to using cream. If cocoa or grated chocolate are to be used, add these to the sugar before adding the liquid. Use one-tenth pound of cocoa or one-fourth pound of cake chocolate for every 2 cups of sugar. If desired, vanilla or some other extract may be added just as the candy is taken from the fire. Use 3 to 6 drops of extract, depending on its strength, for each 2 cups of sugar used. Artificial coloring should be added as the candy is taken from the fire, after having first dissolved the coloring material in a small quantity of the candy at cooking temperature. The candy should be stirred as little as possible, never except to prevent burning. If more appropriate utensils are not at hand, forceps suitable for dipping the paste can be easily made by bending a piece of sterilized stiff wire into a loop so that the points meet each other. Such a piece of wire, with a teaspoon to remove excess coating, is satisfactory. A two-pronged fork if available is better than the wire.

Ground coconut is admirably adapted for addition to the candy coating, to use in place of a candy coating, or for stirring into the paste itself when it is being made.

OTHER FRUIT PASTES

Owing to the fact that Muscadine grape paste has a certain sprightliness which such a paste as that made from the apple lacks, it is very desirable for blending with other fruits. Generally, the blended pastes are the best. Muscadine grape pulp blends excellently with pulp of the apple, pear, guava, or persimmons. Pastes made from other fruits usually are prepared in the same way as Muscadine grape paste.

Guava paste is one of the best of the fruit pastes. In making it, one should take the precaution to cut the paste very soon after it is poured out, as it hardens much more rapidly than grape paste.

Although the apple makes a product which has less character than Muscadine grape paste, its consistency is excellent and it keeps well in storage. The quantity of sugar necessary for making apple paste is greater than that required when Muscadine grapes are used. Three-quarters of a pound to a pound of powdered sugar for each pound of apple pulp is necessary. The apple pulp may be obtained either by preparing a cooked apple sauce or by grinding the white meat of the apple to a pulp and then working it through a purée strainer. The former method is better. The apples for the sauce should be peeled and only the white meaty portion used. This should be cut in small slices or lumps, and if the apples are of average size and juiciness, a pint of water should be added to each dozen apples in preparing the sauce in a saucepan. If a milk pan is used in making the apple sauce, there will perhaps be more evaporation, and for this reason it would be better to use 1½ pints of water for each dozen apples, or to add some water while the apples are stewing if this becomes necessary. In the case of such fruits as the peach, pear, and plum, pulp for paste making can be obtained by preparing a sauce in the same way as for apples. The natural juiciness of the fruit must always be considered in order to determine the quantity of water to use. Pulp from berries, such as strawberries, raspberries, and blackberries, can be obtained in the same manner as that from the grape except that care should be taken to put the pulp through a purée strainer in order to get rid of the small seeds.

Although Muscadine grape paste is perhaps more likely to absorb moisture than it is to become so hard and dry as to be difficult to use, paste made of some kinds of fruit sometimes gets so dry that it is exceedingly hard and leathery, and in this condition it cuts with difficulty and is not easy to use. When in this condition it may be improved by the following procedure:[11]

> Cut into cubes and arrange them in a layer in the bottom of a shallow pan and then add a very little water—no more than they will take up. This will soften the cubes. If not soft enough the first time, the procedure can be repeated. The cubes should be soft enough to pierce with a fork and about like a stiff jelly in consistency. They may be served in a fruit salad, or as a garnish, or used in place of jelly. Or, if preferred, they may be coated with candy.

SUMMARY

Desirable culinary products can be easily and cheaply prepared in the home from surplus home-grown Muscadine grapes.

Such products may be used as a substitute for or to supplement products requiring a cash outlay.

Only simple home utensils are needed in the preparation of these products.

The utilization of fruit heretofore unused will not only prevent waste in the home, but indirectly aid the commercial industry.

The Thomas and the Scuppernong are the best of the standard commercial varieties for culinary purposes.

Jellies, grape juices, sirups, canned grapes, catsups, and conserves are the most desirable products made from Muscadine grapes.

Of the products made from the whole fruit, those requiring a large proportion of sugar are not equal in quality to those in which small proportions of sugar are used.

Muscadine grape sirup is made without the addition of sugar. It is not only a good sirup, but useful as a sugar substitute in preparing other culinary products.

Muscadine grape juice is the cheapest product and the most easily made of all those mentioned in this bulletin. This juice is a pleasant and refreshing summer drink. The Thomas is the best variety for making grape juice, and the Scuppernong ranks second of all the varieties tried. The cold-press method described is the best and cheapest for preparing this grape juice.

---

[11] Directions supplied by the Bureau of Home Economics.

Muscadine grape jelly ranks high as a culinary product. In making it the two essentials are to avoid crystal formation in the jelly and to provide enough pectin to make jelly with sufficient body. The chief factors to be considered are the ripeness of the fruit, the variety, the quantity of sugar used, the general procedure, and the proper use of pectin solution.

Canned Muscadine grapes and spiced Muscadine grapes are desirable products and are relatively cheap. The chief essentials in canning are the removal of seeds, the softening of skins, and the thorough sterilization of fruit and containers.

Muscadine grape catsup is an excellent sauce for serving with cold meats. It is a product easily prepared and relatively cheap.

Muscadine grape conserves are very delicious and wholesome, consisting of raisins, oranges, and nuts combined with grapes. They are especially recommended for school lunches in the South.

Muscadine grape paste is an economical, appetizing, and nutritious substitute for candy and other confections. It is excellent when combined with cheese, especially cottage cheese, as a substitute for a salad course or for dessert. It is particularly desirable for home use, but where grapes are plentiful it has commercial possibilities.

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September 10, 1925

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1455

FITTING, SHOWING, AND JUDGING HOGS

THE SELECTION of high-class animals for the breeding herd improves opportunities for profit in the hog business.

A study of the score card, which attaches relative values to the different points of the hog, is of valuable assistance to inexperienced persons in selecting animals to be placed in the breeding herd.

Fairs and livestock shows offer splendid opportunities for persons to observe the conformation and type of the best individuals of the various breeds.

The following pages contain a discussion of these subjects, which, with the illustrations, should be valuable both to the exhibitor and to persons selling hogs for slaughter.

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FITTING, SHOWING, AND JUDGING HOGS

By E. Z. Russell, *Animal Husbandman, Animal Husbandry Division, Bureau of Animal Industry*

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ENTERING HOGS FOR EXHIBITION

About two or three months in advance of the opening date, application for a premium list should be made to the secretary of the fair at which it is desired to exhibit. All rules, regulations, and conditions, including information regarding switching, draying, pen rent, etc., are printed in the premium lists and should be studied carefully. Dates on which the entries close should be carefully noted and all entries made before that time. The principal hog shows are held between August 15 and December 1.

The fact is well recognized that best results are obtained in swine production when the best animals are used for breeding purposes. Fairs and expositions are recognized as places where one may obtain up-to-date information on the characteristics of the best animals. Breeders follow the practice of showing their animals at livestock shows for the purpose of advertising and selling their surplus. Naturally the right individuals should be selected for show purposes and they should be properly fitted.

The successful showman acquires the knowledge of how to select and properly fit an animal by years of experience. Since there is a wide difference in the ability of individual animals to take on flesh, in their habits, and in the general surroundings under which they are fed and fitted, it is impossible, in a bulletin of this kind, to give specific instructions that will apply in all cases. Some general rules, however, are applicable, and the suggestions in this bulletin are given to assist persons who are inexperienced in fitting.

The time has passed when it was thought to be necessary to produce excessively fat animals for the show ring, thus making them practically worthless as breeding animals. Hogs in good show condition should be active, alert, and should fully display all their qualities. They should not be fat to the extent of being logy, nor should the flesh be "patchy" and the body wrinkled; on the other hand, they must not be too thin to show to the best possible advantage.

There are practically three different groups of hogs to be exhibited: Pigs, including both fall and spring farrow; sows ranging in ages from junior yearlings up; and boars of like ages.

DEFINITIONS OF AGES AND CLASSES

BREEDING ANIMALS

The usual classification of hogs in the premium lists is: Junior pigs, senior pigs, junior yearlings, senior yearlings, aged animals, junior champion, senior champion, grand champion, reserve junior champion, reserve senior champion, and reserve grand champion. There are also group classes, including the young herd, young herd bred by exhibitor, aged herd, aged herd bred by exhibitor, get of sire, and produce of dam.

A junior pig is one farrowed March 1, or after, of the year the show takes place. A senior pig is one farrowed between September 1 of the year prior to the show and March 1 of the year of the show. A junior yearling is one farrowed between March 1 and September 1 of the year prior to the show. A senior yearling is one farrowed between September 1 of the second year prior to the show and March 1 of the year prior to the show. An aged animal is one farrowed before September 1 of the second year prior to the show.

The animals eligible to show for the junior champion are the first-prize junior and the first-prize senior pigs. Those eligible to show for the senior champion are the first-prize junior yearling, the first-prize senior yearling, and the first-prize aged animal. Those eligible to show for the grand champion are the junior champion and the senior champion.

Those eligible to show for reserve junior champion are the first-prize animal defeated as junior champion and the second-prize animal in the class from which the junior champion was selected. Those eligible to show for reserve senior champion are the two first-prize animals defeated as senior champion and the second-prize animal in the class from which the senior champion was selected. Those eligible to show for reserve grand champion are the animal defeated for grand champion and the animal or animals in the class from which the grand champion was selected.

The young herd consists of a boar and three sows that are eligible to show in either the junior or the senior pig class. The herd may contain both junior and senior pigs. The young herd bred by the exhibitor is the same as the young herd, except that the animals shown in this group must have been bred by the exhibitor or (as provided in most classifications) farrowed the property of the exhibitor.

The aged herd consists of a boar and three sows eligible to show in the junior yearling, the senior yearling, or the aged class. It may contain animals from one or all of these three classes. The aged herd bred by the exhibitor is the same as the aged herd, except that the animals must be bred by or (as provided in most classifications) farrowed the property of the exhibitor.

The get of sire consists of four animals of any age of either or both sexes, the get of the same sire. Most premium lists provide that all animals in this class must be owned by the exhibitor, but some shows permit ownership to be by different persons.

The produce of dam consists of four animals of any age of either or both sexes, the produce of the same sow. Some premium lists require that the produce of the dam be of the same litter. Almost all require that the animals shown be owned by the exhibitor.

BARROWS

The classification for barrows is usually the same as for breeding animals, so far as dates from which ages are calculated is concerned. Most premium lists do not provide for aged classes. Some fairs and expositions have classifications for weights instead of ages. A person expecting to exhibit barrows should get advance information regarding the classification at the particular place he expects to show in order properly to select and fit animals for that fair.

DESIRABLE WEIGHTS FOR SHOW ANIMALS

The most desirable weights for show animals of the different classes vary considerably with breeds and the individual animal. Table 1 gives averages of the actual weights taken at the National Swine Shows for the five-year period from 1920 to 1924, inclusive, of the various classes and breeds. The figures show averages of the highest and lowest, also the weighted average of all the premium winners in each class and breed. Reference to this table should be of considerable assistance in determining the best weight at which an animal should be exhibited.

TABLE 1.—*Average weights of premium-winning swine of the various classes and breeds at the National Swine Show, 1920–1924, inclusive*

Class	Berkshire	Chester White	Duroc-Jersey	Hampshire	Poland China	Spotted Poland China	Tamworth	Yorkshire
Aged boars:	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
High	859	856	977	726	1, 056	814	789	749
Low	667	656	787	554	838	690	558	534
Average	749	744	877	640	939	782	680	641
Senior yearling boars:								
High	661	708	792	594	902	734	587	559
Low	568	574	587	424	610	544	421	476
Average	613	629	688	507	750	658	504	527
Junior yearling boars:								
High	597	635	772	493	867	639	510	484
Low	448	474	573	399	622	451	384	387
Average	517	552	684	446	737	548	438	432
Senior boar pigs:								
High	483	480	591	422	588	490	349	415
Low	319	339	430	282	440	294	243	277
Average	393	391	506	337	507	382	297	304
Junior boar pigs:								
High	259	254	264	180	304	260	201	222
Low	165	184	206	134	212	175	139	131
Average	202	220	234	158	251	210	173	181
Aged sows:								
High	755	726	851	641	866	779	652	683
Low	536	552	611	499	701	559	503	508
Average	618	642	721	565	781	677	575	592
Senior yearling sows:								
High	650	645	742	559	762	673	618	543
Low	484	501	591	435	582	497	434	366
Average	571	579	666	497	677	584	507	460
Junior yearling sows:								
High	614	606	641	396	705	598	492	485
Low	458	479	515	305	601	448	358	379
Average	530	531	584	432	638	520	421	412
Senior sow pigs:								
High	456	473	503	360	542	497	386	376
Low	326	346	409	256	443	352	294	244
Average	357	418	451	305	474	403	336	304
Junior sow pigs:								
High	217	262	261	213	292	239	224	225
Low	164	190	202	152	238	177	163	139
Average	181	222	230	182	263	208	188	184

SELECTING THE INDIVIDUALS

PIGS

Junior pigs for show purposes should generally be selected when they are from 12 to 16 weeks of age. Defects that are inherent may not be apparent at that age; consequently care should be taken to select pigs from sires and dams that do not have marked defects in important points. They should come from parents of good conformation, having the ability to take on flesh readily.

Senior pigs for show purposes need not be selected until they are about 5 or 6 months of age, because generally they are not exhibited until they are 11 months of age or more, which gives plenty of time to condition them properly. Senior pigs are generally selected from the ones farrowed in September or October. Any pig farrowed between September 1 and the end of February following may be shown as a senior pig, but pigs of late farrow are always handicapped by size and should not be selected for exhibition unless they are outstanding in quality.

Pigs having long pasterns, crooked hind legs, low backs, or poor heart girth should not be selected, as these defects are apt to become more pronounced as development and increase in weight occur. (Compare figs. 1 and 2.) The pigs should not be weaned until they are 10 weeks of age or older, and they should have access to self-feeders or be carefully hand-fed from the time they begin to eat, which is when they are about 3 weeks of age. The pigs should be on good pasture, with access to a self-feeder containing corn and shorts or middlings. This will tend to prevent any setback or retarding of growth at weaning time. Gradual weaning, by reducing the quantity and quality of the sow's feed and thus causing her to secrete less milk, is advisable.

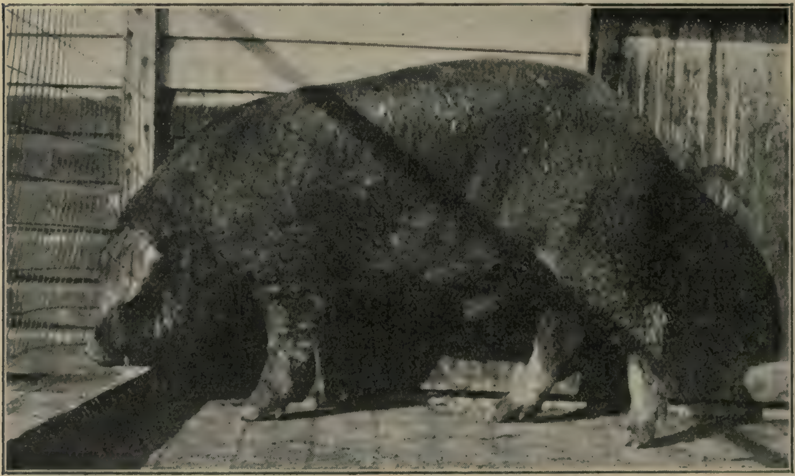

FIG. 1.—A hog with low back, long, weak pasterns, or crooked legs should not be selected for show purposes. This animal is deficient in these points

BOARS

The fitting of a boar for show requires considerable time and care. Since transportation and other expenses connected with showing hogs are considerable, it is inadvisable to try to fit an animal having any serious defects. It is impossible to tell just how any boar will respond to fitting. Some defects may be remedied by feeding, but others will become more pronounced as a result of increased weight.

A few of the important points to be considered in selecting a hog for exhibition are the back, feet, legs, eyes, head, and ears. A boar to show well should have a well-arched back, though not one extremely so. If he has a low back or even one that is flat before fitting, the chances are that he will show a poor back when finished. If the pasterns are long and weak or if the toes spread badly, fitting is very apt to increase rather than reduce the defect. When the

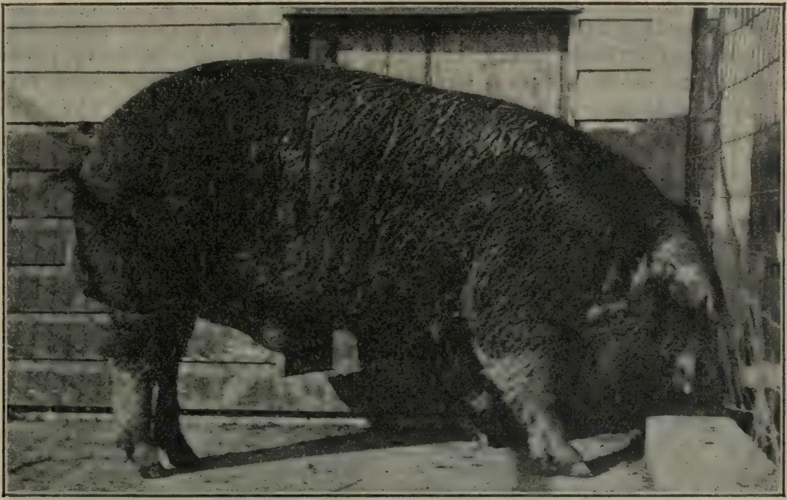

FIG. 2.—A hog with a good back, good pasterns, and straight hind legs

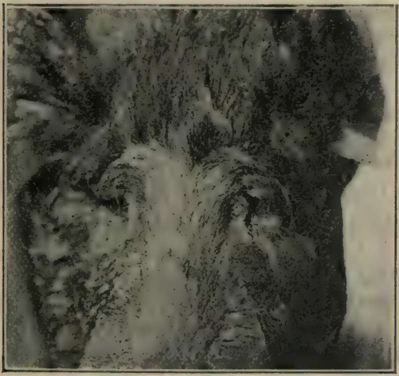

FIG. 3.—A hog with eyesight blurred by heavy eyelids or otherwise is not a desirable show animal

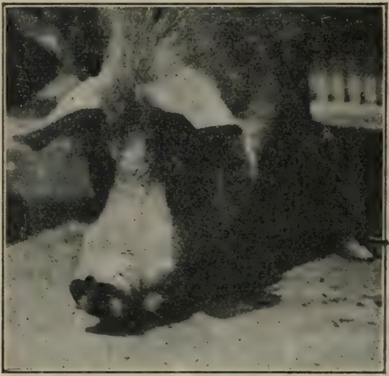

FIG. 4.—A hog selected for show purposes should have clear, wide-open eyes

toes spread the condition may be helped by proper and frequent trimming. If at the beginning the legs are weak and crooked, added flesh will probably make them worse.

A boar should show with good, clear, wide-open eyes. If the eyes are partly closed by fleshy lids, more flesh will probably add to the defect. (See figs. 3 and 4.) Likewise, an extremely rough head that is not well proportioned, or heavy ears that hinder the sight, are seldom improved by fitting.

SOWS

The rules of most fairs permit junior and senior yearling sows to show without their having ever raised a litter of pigs. Some fairs even provide that aged sows that have never raised a litter may show, while others bar them from competition. However, the only profitable breeding animals in a herd are those that produce, and most good judges do and should discriminate against aged sows that have never raised a litter. Sows over 2 years old that have never produced a litter should be sent to market. Figure 5 shows an aged sow that has produced a litter.

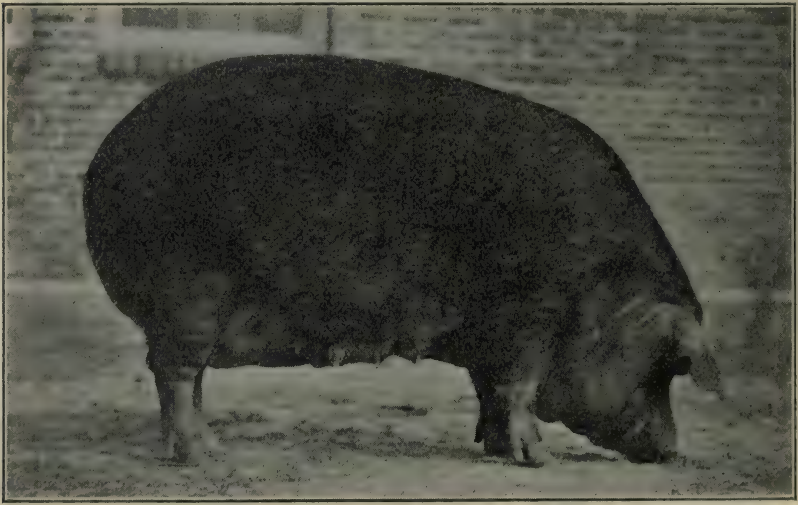

FIG. 5.—A sow showing in the aged class should have produced and suckled a litter

Sows that produce a litter when they are 12 to 13 months old are seldom shown as junior yearlings, because it is difficult to get them into proper condition by show time. Some animals make a very good showing as juniors after raising a litter, but a large percentage of the winners are sows which are shown open (unbred) or bred to farrow after the exhibition.

Sows which are to be shown as junior yearlings should be selected the fall before the breeding season and should not be bred. Only those that give promise of standing well on their feet and legs and of having backs that will not go down should be selected. They must have good length, be smooth in the head, with ears that stand up well and drooping slightly at the tips. Careful examination should indicate that the udder is well developed and that there are no blind teats.

While the rules of most fairs do not require senior yearlings to have raised a litter before being shown, it is best, however, that they do so. A senior yearling sow may raise a litter in the fall or winter after she is 12 months old, or may raise an early spring litter so that the pigs can be weaned in plenty of time to get her into good condition for show. The senior yearling or aged sow bred to raise a litter in the spring before being exhibited in the fall should be in good flesh at the time she farrows. She should farrow early, and every effort must be made to keep her in the best possible condition during the suckling period, so that she will carry a sufficient amount of flesh at fair time without too much crowding.

Sows in this class should be long and deep, have well-developed hams, stand well on their feet and legs, have good heads, rather thin necks but not too long, their eyes clear and wide open, and well-developed udders showing two rows of good teats with at least six in each row. The animals should be shown in good flesh; they should never, however, be "logy." It is a good plan to breed them so that they will farrow soon after the fair. If they are properly fitted and handled they should be in good condition, at that time, to farrow and raise a litter.

BARROWS

A few of the livestock shows and fairs have classifications for barrows. The same general rules should be followed in selecting barrows for exhibition purposes as are followed in selecting the pigs and the boars. The animals should stand well on their feet, have good, strong backs, be smooth, and the body be evenly covered with flesh.

Uniformity of individuals must be closely observed when they are to be shown in groups.

FEEDS AND FEEDING

The feeds to be used and the general conditions under which hogs of all ages are fitted for exhibition purposes are much the same.

Good pasture of alfalfa, red clover, or a variety of grasses is almost a necessity and should be provided from early spring until show time. A variety of feeds should always be provided and abrupt changes avoided. Feeds most commonly used are corn, barley, wheat, rye, oats, and shorts or middlings, tankage, fish meal, old-process linseed meal, and skim milk or buttermilk. The first four are high in carbohydrates and are fat-producing feeds; the others, high in protein, are muscle- and growth-producing feeds.

Corn may be fed on the ear, shelled, or ground. Barley, wheat, and rye should always be ground. Oats may be ground or fed whole in a self-feeder or scattered on a feeding floor.

Natural shade is desirable, but when it is not available, comfortable, cool, well-ventilated quarters in a barn or shed or under an artificial shade must be provided in or adjacent to the pasture (fig. 6). An artificial shade must be of sufficient size so that the sun's rays will not get near the center during the heat of the day; a space 20 feet square is suitable. A framework securely fastened to posts, about 4 feet from the ground, and covered with straw or grass to a depth of 3 to 4 feet, makes a very satisfactory shade.

Frequent applications of water through the covering, or oil sprinkled on the floor, will prevent dust from accumulating.

Pigs which are being fitted for exhibition should be induced to take plenty of exercise. Corn and like feeds should be fed in limited quantities. The greater portion of the ration should consist of shorts or middlings made into a thick slop with milk, with a small amount of linseed meal, tankage, or fish meal added. Oats of good quality, fed either whole or ground, are desirable for growing pigs and are good to use at this time. If fed whole they should be scattered thinly on a feeding floor or fed in a self-feeder. It is thought by some hog raisers that pigs can not be fitted properly without milk. That is not true, though milk is a very valuable feed for that purpose.

The feeding for show should begin immediately after weaning, thus permitting as much growth as possible without laying on too much fat. If fitting begins early, gains in weight may be constant, and rushing and overfeeding will not be required.

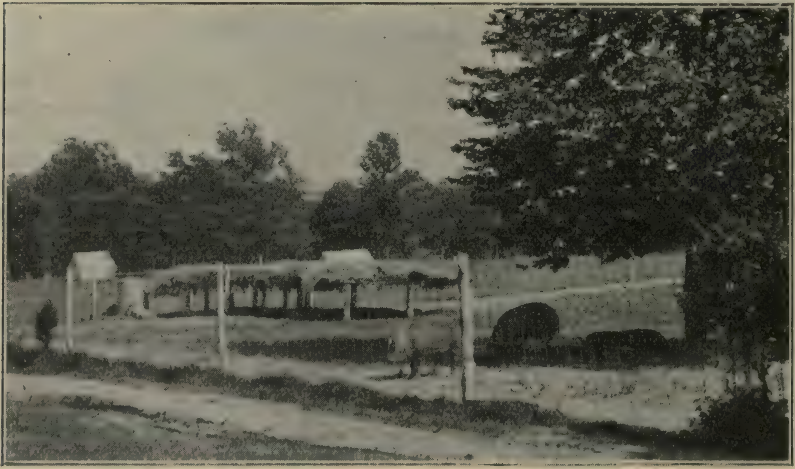

FIG. 6.—Hog lot provided with both artificial and natural shade

Feeding three times a day, except in extremely hot weather, should produce better gains than twice a day. It is best, however, to feed corn but twice a day—morning and evening. The morning feed should be early and the evening feed late to avoid the heat.

In the case of senior pigs there will be about eight months from the time the pigs are weaned until show time. The necessary growth can be made with the use of but very little corn. Shorts or middlings and oats can be used to advantage as a large part of the ration. When pasture is not available, pigs should have free access to third or fourth cutting alfalfa hay.

FEEDING THE BOAR

If the boar has been considerably reduced in flesh during the breeding season the work of building up should begin as soon as the breeding is over. A week or two of rest and quiet should put him in condition to take on flesh. By beginning early he may be well conditioned by show time and not be required to gain too rapidly at any time.

The feed should consist largely of bone and muscle forming feeds. These feeds do not cause so rapid gains as feeds high in carbohydrates, but if the fitting is begun early enough the necessary weight and condition will be obtained.

The feeds named heretofore are sufficient in variety and quality to condition any hog properly. The total ration should not contain more than 25 per cent of corn, unless rapid gains are necessary in order to get the animal in proper flesh by the time the fair is to be held.

Every effort should be made to produce flesh and a skin that is soft and pliable. Slop feeds assist in accomplishing this much better than feeds given dry. Shorts or middlings of good quality are very good to use as the major portion of the boar's feed. To this can be added a small portion of tankage, fish meal, or linseed meal.

If a boar does not eat a sufficient quantity of feed during the fitting process, placing a young boar pig with him is sometimes helpful. The older boar will eat the feed to prevent the pig from getting it. Skim milk and buttermilk are good feeds, but are not absolutely necessary to put a hog in show condition. At times there may be some advantage in using milk when fitting a boar.

The change in conditions and surroundings from the farm to the fairgrounds sometimes causes a boar to refuse his feed, which of course tends to make him show at a disadvantage. Milk is generally a most appetizing feed for a hog and can be procured on most fairgrounds. If it has been used as a part of the ration during the fitting period and the boar refuses it at the fair the herdsman will have practically nothing to offer. The hog that has not been fed milk while being fitted and refuses to eat on the fairgrounds can usually be induced to drink milk in liberal quantities.

FEED FOR SOWS

The methods of feeding and the feeds to be used for the sows are very much the same as for the boars. If the junior and senior yearling sows do not farrow a litter before they are shown, they can be carried along with very little or no corn and easily be in good condition by fair time.

If the junior or senior yearling sows farrow in the spring before the fall in which they are shown, they must necessarily be better fed than if they are carried along without being bred. With aged sows a liberal amount of corn should be used in the ration when necessary to get them in good condition. It is generally advisable to give the feeds in the form of a slop rather than dry.

FEED FOR BARROWS

The barrows may be fed very much the same as the boars, except that corn can safely constitute a greater percentage of the ration.

SEGREGATION OF ANIMALS

The junior boar pigs should be separated from the sows when they are about 4 months of age and placed in a pasture by themselves. Generally, senior boar pigs, junior and senior yearlings, and aged boars can run together. There are, however, instances when boars placed in the same inclosure become nervous and restless and do not eat their feed as they should. When cases of this kind occur they must be kept in a lot or pasture by themselves. If it is found necessary a creep may be made where the pigs can be fed by themselves.

The fitting of a yearling or aged boar is often a difficult problem. Some boars are nervous and irritable and do not take on flesh readily. The time for fitting should be of considerable duration. Most breeders do not breed many sows after the middle of January. As soon as the breeding season is over, the fitting of the boar should begin. All boars being fitted for show should be placed on good pasture and if possible some distance from other hogs, especially sows.

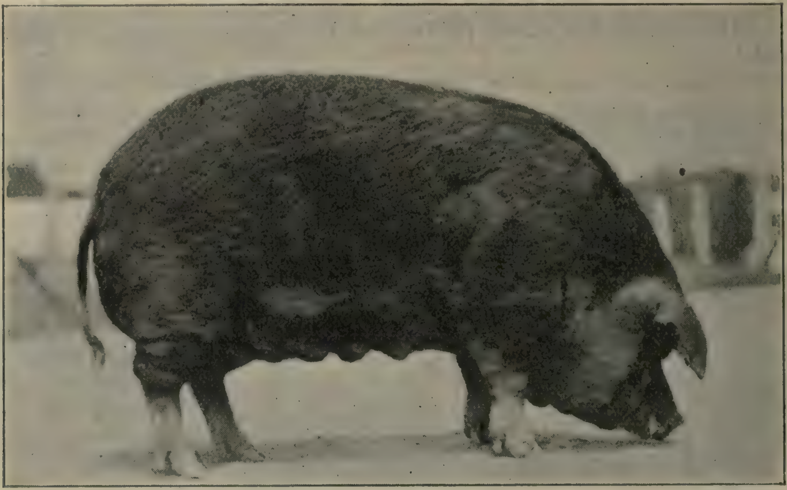

FIG. 7.—If the coat has not shed or has not been clipped it may begin to shed just before show time, as in this case

SHEDDING THE COAT

In order that a boar or sow may show with a good coat of hair, the old coat should be shed before July. If the hair does not begin to shed by about the middle of May, it is advisable to use some artificial means for starting shedding. The following method is suggested: Wash the body of the hog thoroughly with soft water and naphtha soap, then, after drying, grease it with petrolatum or melted lard. A cheap grade of grease or discolored or rancid lard is satisfactory for the purpose. Let this remain for three or four days, then remove it by washing and grease again. Repeat this operation once or twice. For a short time before washing and greasing, feed liberally, as when "flushing" an animal. By following the method described the hair will generally shed. If by the latter part of June the hair has not shed, clipping is advisable. If the old hair does not shed or is not clipped, it may begin to shed just before or about fair time and ruin the appearance of the hog (see fig. 7).

For a period of about two months before the time of the show the bodies of all hogs to be exhibited should be washed thoroughly every 10 days or two weeks.

TRIMMING FEET AND TUSKS

The feet of hogs intended for exhibition should be given careful attention. The feet of any hog can be helped by trimming. Trimming the feet of a large boar may prove to be a difficult task. Some boars are quiet and can be approached and their legs securely tied when they are lying down, making the work of trimming easy. Sometimes crates are used which have plenty of room for the feet and legs to protrude through the bottom (fig. 8). These crates can be suspended by means of ropes and pulleys, and the feet may then be trimmed from below. The pigs and the sows of all ages can be easily held and tied for this purpose.

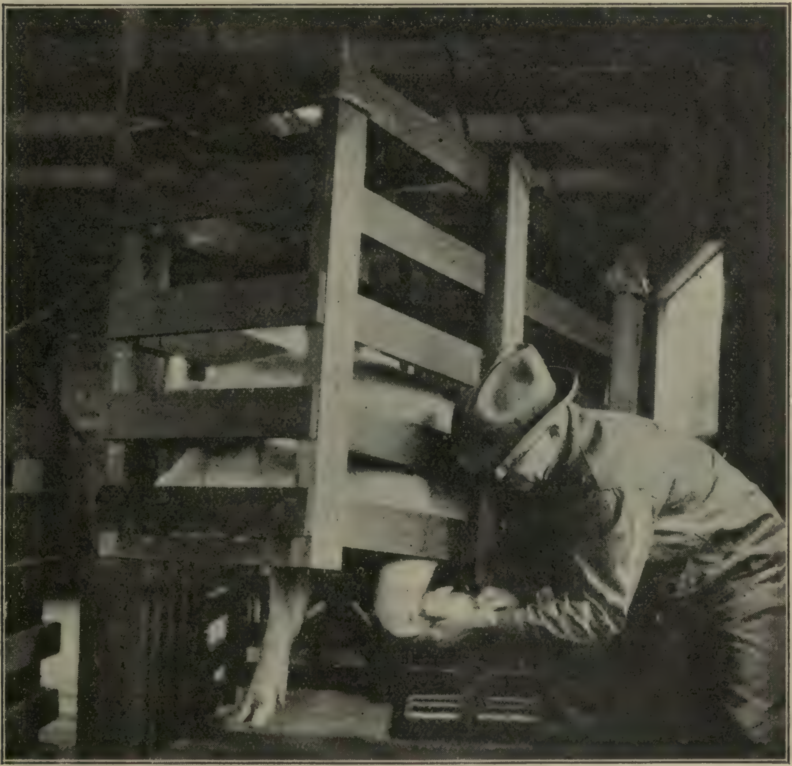

FIG. 8.—Trimming a hog's feet in a crate which is suspended by rope and pulleys

If possible, trim the hog's feet after a rain or keep the animal for several days in a place where its hoofs will be in mud or water. When the hoofs are soft, they can be readily trimmed with a sharp pocketknife having a heavy blade, or a farrier's knife. A rather fine rasp is useful for finishing and smoothing the edges of the hoof. Trim the soles of the feet nearly flat, pulling the knife blade from the back of the hoof toward the toe, leaving the inside of the toes of the hoof slightly lower than the outside. The toes should be closely trimmed, but not close enough to cause lameness. Pressure with the thumb on the trimmed surface will generally indicate when to stop. Trimming should be begun early in the spring and continue during the fitting season at intervals of from four to six weeks.

Most boars are perfectly quiet when at home, but on the fairgrounds, with strange animals around, they must be closely watched. They may attack anyone at any time. Boars of all ages, except spring pigs, should have their tusks closely clipped before starting for the fair.

EXERCISE

Hogs of all classes and ages being fitted for exhibition purposes should have plenty of exercise. Junior pigs usually take sufficient exercise if they are allowed to run in a pasture. Some senior pigs voluntarily move around enough, but some do not, especially during hot weather and near the end of the fitting period. Practically all animals in the aged classes must be driven.

It is best to exercise the hogs in the morning or late in the evening; they should not be moved about in the heat of the day. Every animal should be driven by itself, the herdsman using a short whip or cane and teaching the animal to stop or turn to either side as desired. Complete control of every animal in this way is very necessary that it may be shown properly at the show.

Generally the driving during the fitting period need not begin until about six weeks or two months before the fair. It should be done daily and should last from 30 minutes to an hour.

The practice of exercise should continue while the hogs are on the fairgrounds. Every hog should be driven at least 30 minutes each day.

PREVENTION OF DISEASE

The principal disease with which hogs may come in contact at fairs is hog cholera. Most breeders who follow the practice of showing hogs keep their herds immunized, which, of course, prevents this disease and is the only safe plan. Practically all fairs and expositions require that hogs be immunized before they come on the grounds.

Hog "flu," a respiratory disease, has been more or less prevalent among hogs on exhibition in recent years. Very little is known of the disease and there is no known preventive. When the hogs become affected reduce the feed and keep them as quiet as possible.

When hogs are returned to the farm from the fair they should always be placed in quarters some distance from the remainder of the herd and as strict a quarantine as possible maintained for at least three weeks.

SHIPPING THE HOGS

Shipment should be made so that the hogs will arrive at the fair at least two days before the showing begins; three days would be better. An ordinary box car should be used rather than a stock car. If possible, get a box car with end doors. The regular stock car with slatted sides and ends permits the wind and rain to blow over the animals, possibly causing pneumonia. Any cars in which hogs are shipped to the fair should be thoroughly cleaned and disinfected before loading, because disease germs may be present. The side doors of a box car should be left open and the opening protected with a slatted panel.

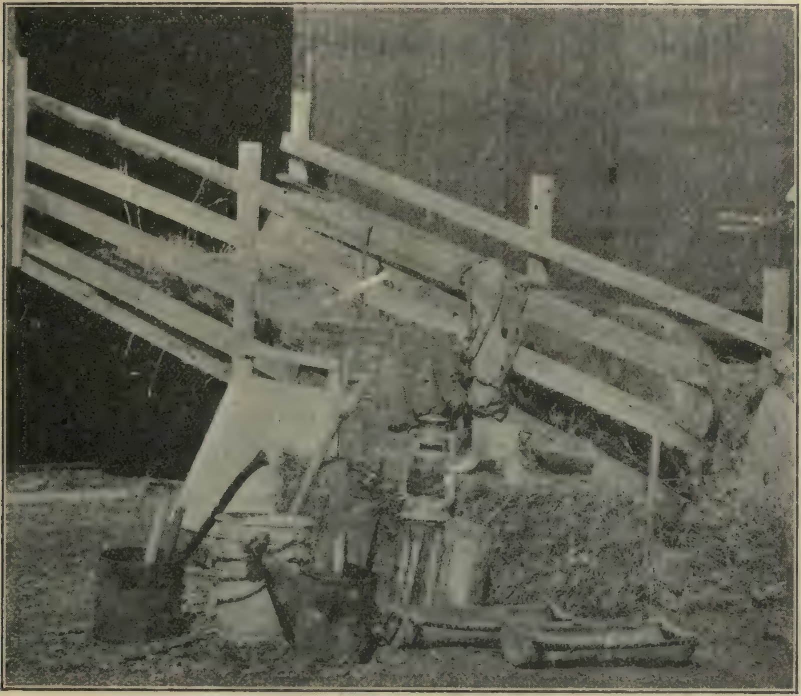

Fig. 9.—Equipment and other articles necessary during shipment and at the fair

Hogs to be shipped for exhibition should not be crated if this can be avoided. Partitions may be placed in the car to divide the different animals. Only such boars as have been fitted together can be shipped in the same pen. The junior and senior sow pigs should be penned together, and the junior and senior yearlings and aged sows together.

If possible, the attendant should sleep in the car while the hogs are in transit. The space in the middle between the doors may be used for this purpose and for the storing of necessary feed and utensils. The following tools will be found necessary or useful in the car and at the fairs: A large-sized sharp hatchet or an ax, a hammer, saw, short-handled fork, spade or shovel, flashlight, sprinkling can, currycomb, two or three brushes, two or three slop pails, barrel of water, at least two strong, light hurdles, hinged hurdle, soap, can of disinfectant, light troughs for feeding in transit and at the fair, pair of clippers, supply of nails of different sizes, and from 20 to 30 feet of good quarter-inch rope (fig. 9).

The car should be well bedded, so that the animals may lie down in comfort. Sand free from gravel is probably best for this purpose. If sand can not be obtained use wheat or rye straw or wild hay. If the weather is at all warm, the bedding should be thoroughly wet before loading begins.

Moving the hogs from the farm to the car should be done with as little discomfort to the animals as possible. The moving should be done early in the morning or late in the evening. If they are moved in the heat of the day they must be watched and, if necessary, sprinkled freely with water to keep them cool. Before the hogs are loaded a barrel of water should be placed in the car ready for use if needed.

At the regular feeding time just preceding loading, the quantity of feed given should be reduced about one-half. A sufficient quantity of the same feeds which have been used in fitting should be taken along in the car, to supply the hogs while in transit. Feeding in transit should be at the same regular periods as when fitting, but the quantity should be reduced about one-half.

If the weather is warm during shipment, the bedding should be kept wet. If this is not sufficient to keep the hogs comfortable they should be sprinkled.

MANAGEMENT AT FAIR

On arrival at the fairgrounds the hogs should be unloaded as soon as possible. If the car is placed within a reasonable distance of the pens it is better to drive the hogs than to have them hauled. They must be driven slowly and not hurried. After they are in the pens give them plenty of water, then a light feed, and let them rest. It is best not to disturb them until the next day, except to feed them and to bed the pens.

After the animals have rested a day, each one should be thoroughly washed. Each morning, after the hogs have been fed and the pens cleaned, they should be given a good brushing. This helps to give the hair a good glossy appearance.

Feeding show hogs on the fairgrounds and keeping their appetite good is sometimes a difficult problem. Junior and senior yearlings and aged boars are the ones that generally quit eating. It is, therefore, advisable to take enough of the same feeds the boars have had while being fitted to last them until the fair is over. When a circuit of shows is being made this can not be done, but if enough is taken to last them through the first fair it will generally be found that a change in feed can then readily be made. There is usually not much trouble in getting the younger animals and the sows to eat on the fairgrounds. After the first day the feed can be gradually increased to full feed, but each individual must be watched to see that its appetite is good.

Before the day for showing, the edges of the hog's ears should be gone over with the clippers just enough to make them look smooth.

The appearance of the coat of most black and red hogs will be improved by the use of a small quantity of paraffin oil of light quality. The oil may be applied with a brush or by saturating a cloth and rubbing it over the hair. For black hogs a limited amount of lampblack may be added to the oil. Talcum powder may be sprinkled over the bodies of white hogs and their appearance improved by brushing.

IN THE SHOW RING

Pigs under 6 months and sows of all ages that have been trained during the fitting period to be driven by a whip or cane can be readily handled in the show ring in the same manner. (See fig. 10.) If any of them appear nervous a small, light hurdle will be of assistance. There is always danger that boars of all ages over 6 months will get together in the ring and fight. A cane is much better than a whip for handling a boar. There should be two attendants, each with a cane and a light hurdle to handle boars.

The attendant should give the judge all the assistance possible to see the animals. They should be moved around as little as possible, care being taken always to have them in a good position. Some attendants continually direct the judge's attention to the strong points by passing their hands over them and by various other motions. Such practices should never be resorted to. Judges selected for shows are competent to pass judgment and will note both the strong and weak points without having their attention called to them. The exhibitor should accept without complaint the awards of the judges.

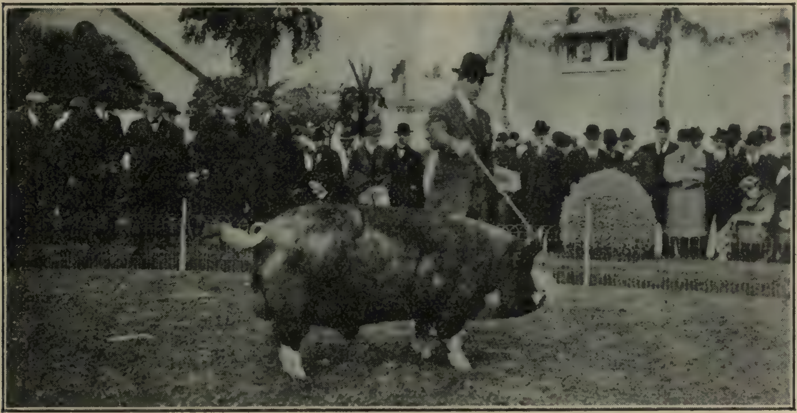

FIG. 10.—Hogs accustomed to being driven during the fitting period are more easily controlled in the show ring

AFTER THE FAIR

When the hogs that have been on exhibition are returned to the farm after the fair, they require careful attention and feeding to get them in good breeding condition. Most animals that have been exhibited carry more flesh than they should to be in prime condition for breeding. The exercise they had while being fitted and at the fair should be continued until they are sufficiently reduced. It is best to reduce the quantity of the feed gradually. The quality should be reduced by replacing the shorts or middlings with wheat bran. A good pasture at this time is just as important as during the fitting period.

SCORE CARD FOR SWINE

The use of the score card and the study of the relative value of the various points as shown by the score is helpful in determining the superiority of one hog over another. The score card, however, is not used by judges in placing the awards in the show ring.

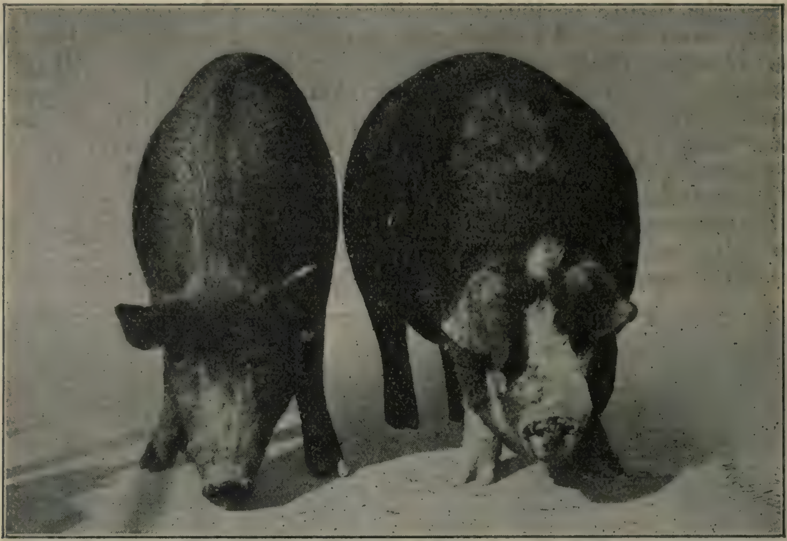

FIG. 11.—Bacon-type sow (left) and lard-type sow (right)

A thorough knowledge of the relative values of the different points of a hog is necessary in determining the value of the animal as a whole. Practice in valuing these points is of great assistance in the proper placing of animals in competition.

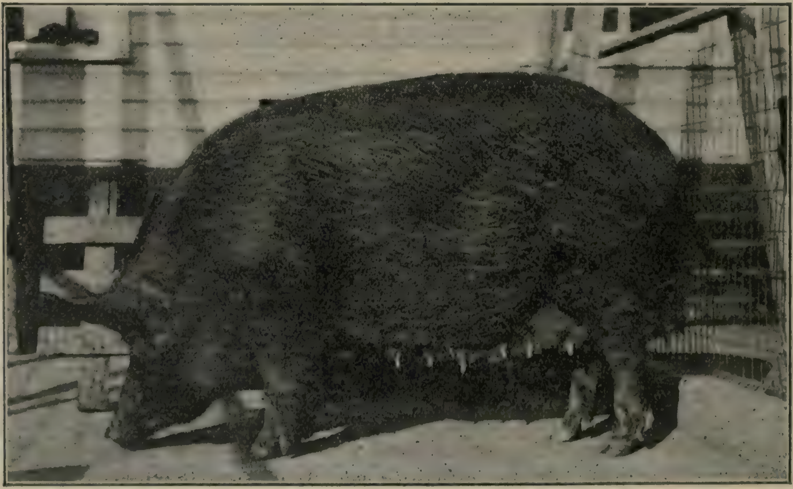

FIG. 12.—A bacon-type hog illustrating good back, deep, long, smooth sides, good feet, and showing good udder development

There are two distinct types of swine in the United States, namely, the lard type and the bacon type. (Fig. 11.) The breeds of the lard type are Duroc-Jersey, Poland China, Chester White, Hampshire, Berkshire, and Spotted Poland China. Those of the bacon type are Yorkshire and Tamworth.

In the examination of a score card it will be noticed that a considerable difference in value is given to various points in the two types. At the present time, however, there are some individuals among the lard-type breeds that conform rather closely in some respects to the bacon type.

The lard type.—The lard-type hog is fairly thickset, having good length and depth, a well-sprung rib, a good, deep, full, round ham, and full, smooth shoulder, the body throughout being well covered with flesh. The legs should be of medium length and the bone of good size and quality. The face should be broad, of medium length and smooth, the eye clear and open. The neck of the boar should be short and thick, that of the sow rather thin; the back of both should carry up well, never sagging; the chest should be full and smooth. The ears should be of medium size, never breaking close to the head so as to cover the eyes and obscure the sight. A hog should always show a good disposition and be tractable. Cross and nervous animals are discriminated against.

The bacon type.—As indicated by the name, animals of the bacon type are grown chiefly because of their superior characteristics for the production of bacon, and in consequence are different in conformation from hogs of the lard type (fig. 12). A bacon hog should have a long, deep, smooth body and a back that carries up well. The hams should be smooth, but not so full and rounded as in the lard-type hog. The legs should be rather long, bones of medium size, neck long and thin, nose pointed, ears upstanding, eyes open and clear. As a whole the bacon hog is smoother than the lard hog.

SIZE OF HOGS

There is no definite standard of size set for the different breeds in the two types. Hogs of all breeds up to about 10 months of age when fattened for market show very similar weights. Market pigs of different ages should weigh approximately the following:

Pigs 10 to 12 weeks of age	30 to 45 pounds.
Pigs 5 to 6 months of age	100 to 175 pounds.
Pigs 8 to 10 months of age	200 to 275 pounds.

Breeding animals over 2 years of age in good condition should weigh about as follows:

Duroc-Jersey:	
Boars	650 to 950 pounds.
Sows	500 to 700 pounds.
Poland China:	
Boars	650 to 1,000 pounds.
Sows	500 to 700 pounds.
Chester White:	
Boars	600 to 900 pounds.
Sows	500 to 700 pounds.
Berkshire:	
Boars	600 to 850 pounds.
Sows	450 to 650 pounds.

Hampshire:	
Boars	550 to 850 pounds.
Sows	450 to 650 pounds.
Spotted Poland China:	
Boars	650 to 950 pounds.
Sows	500 to 700 pounds.
Yorkshire:	
Boars	600 to 900 pounds.
Sows	500 to 700 pounds.
Tamworth:	
Boars	600 to 900 pounds.
Sows	500 to 700 pounds.

In all breeds, individual animals of extra quality may show a greater weight than that given above.

HOW TO SCORE

The scale of points given herewith and illustrated in Figure 13 indicates perfection in a hog. The scale as shown is for breeding animals in good condition, yet it may be applied to market hogs.

A good breeding animal is one that is not overfat nor yet thin. It is best to look the animal over carefully at first to determine its general condition and conformation. Is it too fat or too thin? In what respects does it fall short? To examine a hog critically, stand some distance from it, view it from both sides and from front and behind. Retain a good mental picture of the animal as it stands.

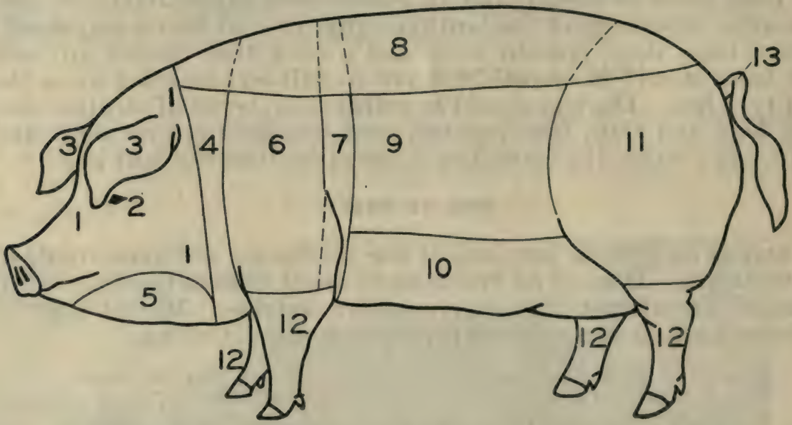

Fig. 13.—Points of swine designated on score card. 1, Head and face; 2, eyes; 3, ears; 4, neck; 5, jowl; 6, shoulder; 7, chest or heart girth; 8, back and loin; 9, side and ribs; 10, belly and flank; 11, ham and rump; 12, feet and legs; 13, tail

Be sure to have it posed as naturally as possible. When the head is held high it may indicate low back; if held low it may show a good back, when in fact the back may actually be low. When the body is not straight, wrinkles may appear which are not true skin wrinkles. If the hind feet stand forward under the belly the legs may appear crooked.

When fitting an animal intended for show or for scoring, it should be driven often, so that it may be easily handled with a whip or cane when shown. It is difficult to score properly a nervous or scared animal.

After carefully noting the animal and getting it well pictured as a whole, use the score card and rate it point by point. From the mental picture of what is regarded as perfect for the various points, make deductions as found necessary in making the score for each particular point. For instance, the eyes are scored 2 points; if there is no defect or blemish, score the 2 points; if the flesh partially covers the eyes, obstructing the sight, deduct one-half or 1 full point, or as much as seems proper. If the shoulder is not smooth or is too coarse, deduct 1 or 2 points or such other number as is deemed best.

Each animal is scored separately and recorded, the points for each are added, and the one standing nearest to 100 is rated first, the one receiving the next greatest number of points is placed second, etc.

The scores shown in the accompanying form of score card for the various breeds are scores recommended by the record associations of these breeds. The points shown in the column under head of Department of Agriculture are the score recommended by the department for general lard-type and bacon-type hogs.

Score cards for the various breeds of hogs as drafted by the respective record associations and the U. S. Department of Agriculture

Points	Lard type							Bacon type		
	Duroc-Jersey	Poland China	Chester White	Spotted Poland China	Hampshire	Berkshire	Department of Agriculture	Tamworth	Yorkshire	Department of Agriculture
Head and face	4	4	4	4	4	7	4	5	6	5
Eyes	2	2	2	2	2	2	2	2	1	2
Ears	2	2	2	2	2	3	2	2	1	2
Neck	2	2	2	2	2	3	2	2	3	3
Jowl	2	2	2	2	2	3	2	2	1	2
Shoulder	6	6	6	6	6	6	6	6	6	6
Chest	12	12	12	12	12	6	12	10	8	10
Back and loin	14	14	14	14	15	16	14	12	10	12
Side and ribs	9	8	9	8	8	6	8	12	13	12
Belly and flank	4	4	4	4	6	5	4	4	3	4
Ham and rump	10	10	10	10	10	10	10	10	15	10
Feet and legs	9	10	9	10	10	10	10	8	8	8
Tail	1	1	1	1	1	2	1	1	1	1
Coat	3	3	3	3	2	3	3	3	4	3
Color	2	2	2	2	2	3	2	2	1	2
Size	8	8	8	8	5	6	8	8	7	8
Action and style	3	3	3	3	4	6	3	3	5	3
Condition	2	3	2	3	4	3	2	2	2	2
Disposition	2	2	2	2	3	--------	2	2	--------	2
Symmetry of points	3	2	3	2	--------	--------	3	4	5	3
Total	100	100	100	100	100	100	100	100	100	100

DESCRIPTION OF POINTS

The points given below are those considered by judges when judging in the show ring, when judging with a score card, and when making selections for the breeding herd.

HEAD AND FACE

Duroc-Jersey, Poland China, Chester White, and Spotted Poland China:

Qualifications: Short, good width between eyes, smooth, slightly dished, well tapered down to nose.

Objections: Coarse, narrow between eyes, face straight or decidedly dished.

Berkshire:

Qualifications: Face well dished, snout short and broad.

Objections: Snout long, face too straight.

Hampshire:
Qualifications: Medium length, rather narrow face, nearly straight, medium length.
Objections: Large, coarse, crooked nose or too much dished.
Yorkshire:
Qualifications: Moderate length and size, some dish toward snout.
Objections: Short, wrinkled face, decidedly straight.
Tamworth:
Qualifications: Fairly long, wide between ears, slightly dished.
Objections: Short, wrinkled face, too much dished.
All breeds: Clear, bright eyes, wide open.
Objections: Small, sight obstructed by wrinkles or fat.

EARS

Duroc-Jersey, Poland China, Spotted Poland China, Chester White:
Qualifications: Medium in size, moderately thin, set well apart, pointed outward and forward, drooped at tip.
Objections: Large or heavy, breaking close to head, obscuring sight, not under control, too rigid or erect.
Hampshire:
Qualifications: Medium length, thin, slightly inclined outward and forward.
Objections: Large, coarse, drooped and not under control.
Berkshire:
Qualifications: Medium size, set well apart, inclined forward, carried fairly erect.
Objections: Large, coarse, drooped.
Tamworth:
Qualifications: Rather large, carried rigid and inclined forward.
Objections: Too small or drooped.
Yorkshire:
Qualifications: Medium size, inclined out and slightly forward.
Objections: Large, drooped.

NECK

Lard breeds:
Qualifications: Short, thick, deep, well set to shoulders, slightly arched. Sow's neck not so thick as that of boar. Hampshires should not have neck so thick as other breeds.
Objections: Long, narrow, flat on top.
Bacon breeds:
Qualifications: Fairly long and muscular.
Objections: Short, thick.

JOWL

Duroc-Jersey, Poland China, Chester White, Spotted Poland China, and Berkshire:
Qualifications: Broad and full, flesh not hanging too low; fullness carried to point of shoulders.
Objections: Too large, loose, flabby, rough, thin, and wedging.
Hampshire:
Qualifications: Light, neat, firm, tapering from neck to point.
Objections: Large, broad, flabby, uneven.
Bacon breeds:
Qualifications: Medium, smooth, not carried too far back toward neck.
Objections: Large, flabby.

SHOULDERS

Lard breeds:
Qualifications: Moderately broad, deep, full, smooth, in line with side, not extending above line of back.
Objections: Open, small, extending above line of back, rough, coarse, and shielded.
Bacon breeds:
Qualifications: Large, not massive, smooth, not extending above line of back.
Objections: Open, rough, small, and narrow.

CHEST

All breeds:

Qualifications: Deep, full, and wide, even with shoulders, sides extending down to line of belly.

Objections: Flat, low behind shoulders, tucked in back of forelegs.

BACK AND LOIN

Lard breeds:

Qualifications: Strong, slightly arched, medium breadth, even and smooth from shoulder to ham, full at loin.

Objections: Back low or weak, narrow, uneven, too broad, and flat.

Bacon breeds:

Qualifications: Long, strong, arched, not wide, smooth and even.

Objections: Back flat or low, short, uneven.

SIDES AND RIBS

Lard breeds:

Qualifications: Good length, deep, even, and full between shoulders and ham. Ribs well sprung at top and bottom. Sides coming well down to line of belly.

Objections: Sides flat, flabby, creased. Ribs not well sprung, lacking depth.

Bacon breeds:

Qualifications: Long and very deep, even from shoulder to ham. Ribs well sprung and carried well up to flank.

Objections: Sides too fat, rough, not carrying sufficient length and depth.

BELLY AND FLANK

All breeds:

Qualifications: Straight on bottom, carried out full to line of sides. Flank full and let down to line of belly.

Objections: Narrow, tucked up, sagging and flabby.

HAM AND RUMP

Lard breeds:

Qualifications: Ham, good width, full, long, smooth, and fleshed well down to the hocks. Rump, same width as back and slightly rounding from loin to root of tail.

Objections: Hams, narrow, rough, too high in crotch, flabby. Rump, steep, narrow.

Bacon breeds:

Qualifications: Hams, long, smooth, not so wide or well rounded as in lard breeds, coming well down to hocks. Rump not too steep or too narrow.

FEET AND LEGS

All breeds:

Qualifications: Legs medium length, set well apart and squarely under body, straight, nicely tapering, well muscled, and of medium size. Feet short in pastern, strong, toes close together.

Objections: Legs extremely long or short, weak, crooked, coarse, close together. Toes long, weak, and spreading.

TAIL

All breeds:

Qualifications: Set well up. Medium size, tapering from root to end, inclined to curl.

Objections: Extremely slim or heavy, too long or bobbed.

COAT

All breeds:

Qualifications: Fine, straight, smooth, fairly thick, covering body well except belly.

Objections: Bristles, swirls, coarse, curly, very thin.

COLOR

Duroc-Jersey and Tamworth:

Qualifications: Cherry or golden red without any mixtures.

Objections: Very dark or very light, black or white spots in hair or on body.

Poland China and Berkshire:
  Qualifications: Black with white on feet, nose, tip of tail and occasional spots on body; may show tinge of bronze or copper color.
  Objections: Numerous large, white spots on body, or white legs.
Hampshire:
  Qualifications: Black with exception of white belt encircling body, including forelegs.
  Objections: White high up on hind legs or extending more than one-fourth the length of body, or solid black.
Spotted Poland China:
  Qualifications: Black with at least 20 per cent of body white, which may be in large or small spots.
  Objections: Not white enough on body to meet requirements.
Chester White and Yorkshire:
  Qualifications: White (dark spots on skin are objectionable, but do not disqualify).
  Objections: Any other color than white in hair.

SIZE

All breeds:
  Qualifications: Approximate size of aged animals given on pages 3 and 4 of this bulletin. Other ages should be in proportion.

ACTION AND STYLE

All breeds:
  Qualifications: Active, vigorous, graceful, gentle, and easily handled.
  Objections: Awkward and wabbling, clumsy, sluggish.

CONDITION

All breeds:
  Qualifications: Skin smooth and mellow, flesh evenly distributed over entire body.
  Objections: Too fat, skin diseased or harsh to touch, hair coarse and rough.

DISPOSITION

All breeds:
  Qualifications: Quiet, gentle, and easily handled.
  Objections: Cross, restless, wild, or sluggish.

SYMMETRY

All breeds:
  Qualifications: The adaptation of all points combined to make the desired type or model.

CONCLUSION

The foregoing discussion presents the requirements necessary for selecting, fitting, and exhibiting hogs in a way that will display them to best advantage. The section devoted to scoring is intended to assist the less experienced judge in accurately comparing two or more animals.

Experiments have clearly shown that animals of the best type and quality make the best use of the feed consumed and consequently are the most profitable. This being true, the ability to judge accurately and quickly the existence of good conformation and to recognize at the same time weaknesses and defects in a hog is a valuable asset to the hog man, whether he is in the business of breeding and showing hogs or producing hogs for market.

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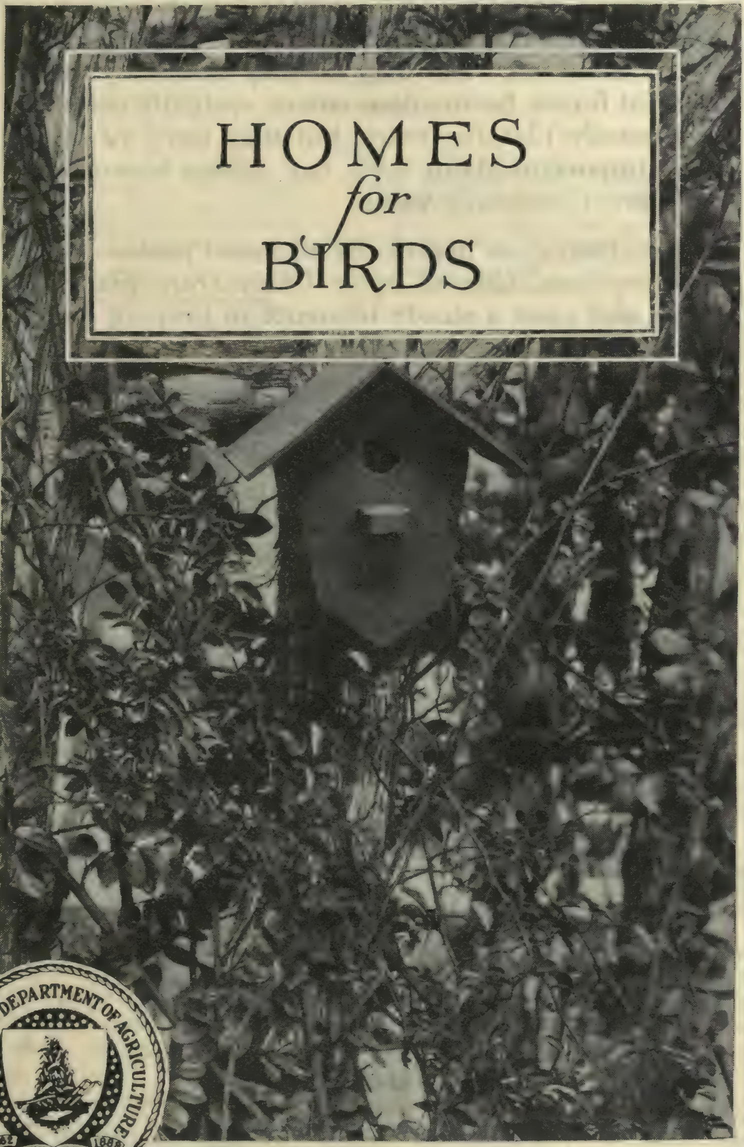
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1456

HOMES *for* BIRDS



BIRDS appeal strongly to the interest and affection of mankind. Not only do they charm by their graceful forms, harmonious colors, sprightly actions, and usually pleasing notes, but they have an even more important claim upon our esteem because of their great economic value.

Birds feed upon practically all insect pests. They are voracious, able to move freely from place to place, and exert a steady influence in keeping down the swelling tide of insect life.

For economic as well as for esthetic reasons, therefore, an effort should be made to attract and protect birds and to increase their numbers. Where proper measures of this kind have been taken an increase of several fold in the bird population has resulted, with decreased losses from depredations of injurious insects.

This bulletin, one of a series (see footnote, page 2) describing the best methods of attracting birds, deals with nest boxes and other homes for birds, and is adapted for use throughout the United States. It supersedes Farmers' Bulletin No. 609, Bird Houses and How to Build Them.

Washington, D. C. **Issued July, 1925**

HOMES FOR BIRDS

By E. R. Kalmbach, *Biologist*, and W. L. McAtee, *in Charge, Division of Food Habits Research, Bureau of Biological Survey*

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THAT THE AFFECTION felt by many people for birds should manifest itself in the provision of homes for them is highly appropriate. Moreover, aiding birds in their homemaking has a distinctly utilitarian side. From either point of view, provision of nest boxes and other home facilities for birds will be well repaid, and it is the object of this bulletin to make helpful suggestions for the purpose.

ORIGIN OF THE NEST-BOX IDEA

Discussions of the origin of the nest-box idea have placed the date at most a few centuries back, but circumstantial evidence indicates a much greater age for it. Certain uncivilized tribes have the greatest facility for taming wild creatures, and often their homes are shared by a variety of furred and feathered pets. This is no modern development; it is an ingrained trait of the people, and is the very thing that resulted in the subjection of all domesticated animals, a process the beginnings of which are lost in antiquity. We may be sure that primitive man had pets, among them birds, and that without doubt he provided nesting facilities for some of them.

In the cradle of the human race, Asia, we should expect to find indications of primitive care for birds, and the expectation is not disappointed. Early records of Asia Minor testify to the use of doves or pigeons for carrying messages, and such use necessitates the maintenance of houses for the birds; these must have been provided in very early stages of the domestication of the birds, certainly at a remote period. The shelves for swallows in Japanese temples and the feeding towers with nesting places maintained by the Brahmans of India are no innovation; on the contrary, they must have, among these nature worshipers, an antiquity going back to the very beginnings of their religions.

USE OF NEST BOXES IN THE UNITED STATES

It is said that the early colonists of America found that some of the more agricultural tribes of eastern Indians hung up gourds for purple martins on trees trimmed to bare stubs for the purpose. How old the practice is we have no means of knowing, but it has been continued by white men to this day in but slightly modified form throughout the Southeastern States. The provision of houses for purple martins and shelves for eaves and barn swallows dates back to colonial times.

Since the modern movements for bird study and protection have been in progress, the number of people furnishing homes for the birds has increased immensely in every quarter of our land. Their success in attracting bird tenants has been great, and their hospitality has been accepted by almost every kind of bird whose original home can be imitated by man.

The roll[1] of species in the United States known to have nested in bird boxes or on supporting devices built for them now includes 45 names, as follows:

Mountain bluebird.
Western bluebird.
Eastern bluebird.
Robin.
Chestnut-backed chickadee.
Mountain chickadee.
Carolina chickadee.
Black-capped chickadee.
Plain titmouse.
Tufted titmouse.
Red-breasted nuthatch.
White-breasted nuthatch.
Brown creeper.
House wren.
Bewick wren.
Carolina wren.
Brown thrasher.
Violet-green swallow.
Tree swallow.
Barn swallow.
Cliff swallow.
Purple martin.
Song sparrow.
English sparrow.
House finch.
Purple grackle.
Orchard oriole.
Starling.
Phoebe.
Ash-throated flycatcher.
Crested flycatcher.
Red-shafted flicker.
Yellow-shafted flicker.
Golden-fronted woodpecker.
Red-headed woodpecker.
Downy woodpecker.
Hairy woodpecker.
Screech owl.
Saw-whet owl.
Barn owl.
Sparrow hawk.
Mourning dove.
Wood duck.
American goldeneye.
Hooded merganser.

INCREASE OF BIRDS DUE TO PROVISION OF NESTING FACILITIES

Not only is it possible to attract numerous species of birds by supplying boxes and other nesting facilities, but it has been amply proved that the total bird population on a given area can be raised far above normal by these and other methods of attraction.[2]

The average number of birds over the eastern United States is a little more than one pair to the acre, but it seems fairly easy to increase this number in suburban, residential, and parked areas to about 10 pairs to the acre. This has been accomplished at Golden

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[1] Information furnished the Biological Survey as to species additional to this list will be appreciated.

[2] For information on the use of protective devices, food-producing plants, and winter feeding, consult Farmers' Bulletins on "How to attract birds," relating to the following sections of the country, respectively: No. 621, Northeastern States; 760, Northwestern States; 844, Middle Atlantic States; and 912, East Central States; also No. 1239, "Community bird refuges," of general application.

Gate Park, San Francisco, for instance, with 404 pairs to 40 acres; at Olney, Ill., 70 pairs to 8 acres; and at Chevy Chase, Md., 224 pairs to 23 acres. Even higher records have been made, as 135 pairs to 5 acres at Wild Acres, Md., near Washington, D. C.,[3] and the number may run up to a much larger figure on a single acre where a thriving colony of purple martins is domiciled.

RESULTS OF INCREASING THE NUMBER OF BIRDS

The larger the number of birds the greater the drain upon their food supply. If this food supply consists chiefly of injurious insects, man profits; if of the products of his cultivation, he suffers. All things considered, however, it is better to have more birds, for, although the injurious individuals or kinds can be controlled or suppressed, the useful species, if not present in time of need, can not be hastily summoned.

Experience shows that those who have increased the number of birds on their property have had cause for satisfaction rather than regret. A case in point has been contributed by B. R. Bones, of Racine, Wis., who gives the following account of some of the benefits he received from encouraging birds:

> I commenced as a companion and disciple of Doctor Hoy over half a century ago, and have fitted my place for a bird paradise, with plenty of trees and shrubbery and 1 acre of lawn. Commencing with a single pair of grackles about 20 years ago, I have now over 200. * * * I counted 17 on the first furrow plowed this spring. White grubs are about played out, and I have not seen a cutworm in five years.

E. H. Forbush, State ornithologist of Massachusetts, is convinced that bird attraction pays. He says:[4]

> My first attempt at availing myself of the services of the birds in an orchard was made in 1894–95. * * * The winter birds were attracted to the orchard and frequented the trees during the entire winter. * * * In the fall, winter, and spring they destroyed many thousands of the imagos and eggs of the fall and spring canker-worm moths, the eggs of the tent caterpillar, and probably also the pupae and imagos of the codling moth, besides scales, tineids, and other enemies of the trees. When spring came, efforts were made to attract the summer birds to the orchard. These attempts met with such signal success that, although most of the eggs and young birds were destroyed by cats, boys, crows, and other agencies, the remaining injurious insects were so completely disposed of by the birds that the trees bore luxuriant foliage during the entire summer and produced a good crop of fruit. This occurred in a season when both the tent caterpillar and the cankerworm were remarkably prevalent. The only other orchard in the neighborhood that produced any fruit whatever was that of the nearest neighbor. This had been partly protected by tarred bands and partly by the birds from my place. Elsewhere in the town most of the apple trees were defoliated, and very few produced any fruit that year.

Mr. Forbush has claimed[5] equal efficiency on the part of the birds in ridding a garden of weeds:

> In our garden we attempted to keep the weeds in subjection. This in 1900 was almost an impossibility. In 1901 it was a serious task and necessitated frequent weeding or hoeing all summer and into the fall. In 1902 the labor was much lightened, and this was in part due to the birds. All

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[3] For details as to these density records consult the series of Department Bulletins on bird censuses: No. 187, 1915; No. 396, 1916; and No. 1165, 1923.

[4] "Useful birds and their protection," pp. 150–151, 1907.

[5] "Two years with the birds on a farm," pp. 12–14, 1908.

> farmers know that while hoed crops in the main may be kept nearly free from weeds it is impossible to weed a squash or melon patch without injuring the plants. Such crops invariably foul the land. It is also very difficult to keep all fences and borders of fields clear of weeds. We depended mainly on the birds to take care of such weed seeds as were left in the squash or melon patch or along the borders, and they did their work well.
>
> The first year birds were not numerous enough to destroy all the weed seed; the second year there was hardly enough seed to gather an increased number of birds.

A frequently cited European example of the value of attracting birds also is worth repeating. On the estate of Baron von Berlepsch, in Germany, bird attraction methods of every kind were practised, and among other things more than 2,000 nest boxes were supplied, of which about 90 per cent were occupied. During an outbreak of the oak leaf-roller[6] other woods in the region were entirely defoliated, but that on the Berlepsch estate stood out as a green oasis. With this example before them, municipal and provincial governments in Germany took up the providing of nest boxes for birds, and more than 9.000 were erected in the Grand Duchy of Hesse alone.

HOUSING BIRD ENEMIES OF INSECTS

Adoption of bird houses as a means of enlisting the services of birds as allies in combating an insect pest was successfully tried out in the case of an outbreak of the larch sawfly[7] near Manchester, England. From 1908 to 1914, 400 boxes were placed and 81 per cent of them occupied. It was considered that birds did a great deal toward the ultimate control of the pest. In this country boxes have been put up about many cranberry bogs to attract tree swallows as enemies of cranberry moths. In some parts of the South it has long been the practice to supply plenty of gourd nests for martins about fields, for the good the birds do in feeding on crop pests. At Winona, Ind., it is reported that the establishment of several large colonies of purple martins was followed by a great reduction in the numbers of mosquitoes. The use of bird boxes to minimize damage by woodpeckers to telephone poles, houses, and other structures also has been tried to some extent.

A concrete instance of the use of bird boxes in the United States for practical ends is described in the following quotation from C. C. Clute:

> I know one farmer in particular who lost during one summer three rows of corn 40 rods long. The corn grew next to a fence-row heavily sodded with bluegrass, which produced swarms of grasshoppers. For the sake of the experiment alone, for this farmer was a skeptic, last spring he put up 21 bird houses, placed 2 rods apart, on the fence along the 40 rods. The houses were some that he and the boys had made during the winter months from dry-goods boxes obtained in town. Thirteen of the 21 houses were inhabited during the following summer, 6 by wrens, 4 by bluebirds, and 3 by colonies of purple martins. The grasshoppers that summer made a rich living for the birds, and when the fall came that farmer had the satisfaction of gathering 23 bushels of corn from the three rows that grew next to the fence, right where there had been no corn at all the year before.[8]

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[6] *Tortrix viridiana.*

[7] *Nematus erichsonii.*

[8] Iowa Conservation, vol. 1, no. 1, p. 12, January–March, 1917.

PRINCIPLES OF NEST-BOX CONSTRUCTION

When one recalls the unusual, inconvenient, and dangerous locations sometimes chosen by hole-nesting birds to conduct their family affairs, it would appear that almost any facility, however crude, might serve as an inducement to nest building. When we see a house wren nesting in a discarded tin can, an old hat, the empty sleeve of a scarecrow, or the cranial cavity of a weathered cow's skull, it seems that this species would not hesitate to use anything in the shape of a nest box.

The actual needs of hole-nesting birds are few, and may often be met by a small expenditure of time and work. To make the proffered nesting facilities safer, however, and probably more comfortable for the occupants, certain principles of construction, design, and location need to be observed. A well-built bird house should be durable, rain-proof, cool, and readily accessible for cleaning. Furthermore, by adopting high standards of neatness and rustic beauty in the construction of bird houses, they may be made not only to serve the strictly useful purpose of encouraging beneficial species but also to add a touch of attractiveness to what might otherwise be a prosaic dooryard.

MATERIALS

For the person wishing to construct his own bird houses, wood is by all means the best building material. Metal should be avoided because it is a great conductor of heat. Pottery nest boxes have some points in their favor, but there are no facilities for their manufacture in the average home workshop. Nest boxes constructed of tar paper or similar products have no particular advantage over the wooden ones, and the use of these materials is impracticable for some of the larger houses. In the choice of wood, an easily workable kind, as cypress, pine, or yellow poplar, is preferable; the first-named is the most durable. Sawmill waste (rough slabs with the bark on) furnishes cheap and satisfactory material for rustic houses.

PAINT

Where a rustic finish is not sought, paint is unobjectionable and greatly enhances the weathering qualities of bird houses. Modest tones, as brown, gray, or dull green, are generally to be preferred. Martin houses and others that are placed in exposed situations, however, may be painted white to reflect heat.

PROTECTION FROM RAIN

Roofs should be made with a sufficient pitch to shed water readily; or, if level, or nearly so, they should have a groove cut across the under face of the overhanging part (fig. 1, *A*) to prevent water from draining back into the interior. This overhang in the average house should be from 2 to 3 inches, so as to protect the entrance hole from driving rain. The opening of the nest cavity itself may be bored at an upward slant to aid in keeping out water. A strip of metal or roofing paper often helps to make the ridge of the nest box thoroughly waterproof; flat roofs should either be wholly covered with some such material or else heavily painted. In latitudes where freezing weather is the rule in winter, bird houses will last longer if the sides are prolonged beyond the bottom of the box, thus draining off water which otherwise might freeze in the crack between bottom and sides and wedge them apart. To provide for the contingency that some water may get inside the box, a few small holes may be made in the bottom.

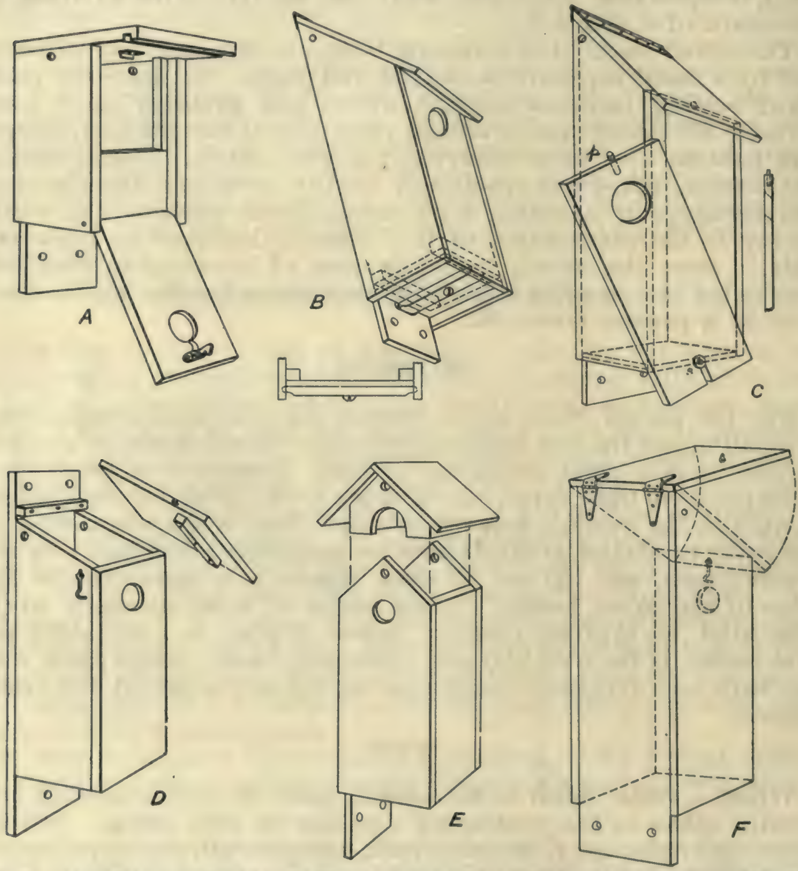

FIG. 1.—Accessible nest boxes. *A*, Hinged front held up by a catch; *B*, removable bottom, released by the slight turn of a cleat; *C*, swinging front, held in place by the pin *p* and by tightening the screw *s*; *D* and *E*, removable tops; *F*, hinged top

PROTECTION FROM HEAT

If attention be paid to the principle of cool construction, death of nestlings during periods of excessive heat may be lessened. Wood is in itself a fairly good heat insulator; but it must be remembered that the interior of the average nest box is small, and a single opening near the top permits little ventilation. One or two small auger holes through the walls near the top of the box will give a limited circulation of air without producing drafts. A double roof or a compartment above the nest proper will also serve as an excellent insulator. In the colony houses built for martins this feature can be easily included, and the added comfort and safety afforded the nestlings will more than repay for the extra work. In martin houses, however, owing to the low position of the entrance hole and the possibility of producing objectionable drafts, ventilating holes in the compartments themselves should be confined to a single one of small size near the top or left out entirely.

ACCESSIBILITY

All bird houses should be placed so as to be readily accessible and built so as to be easily opened and cleaned. To those interested in studying the life history of the nestlings a readily opened box is a great aid. A number of arrangements may be used to permit inspection of the nest, several of which as applied to simple houses are illustrated in Figure 1. A pane of glass sliding in a groove just beneath the removable side will allow observations without subjecting the birds to exposure or causing a disturbance of the nest material. Other reasons that demand accessibility to the interior of bird houses are mentioned in the section on sanitation, page 19.

TABLE 1.—*Dimensions of nesting boxes for various species of regular box-inhabiting birds and the height at which they should be placed above the ground*

Species	Floor of cavity	Depth of cavity	Entrance above floor	Diameter of entrance	Height above ground
	Inches	*Inches*	*Inches*	*Inches*	*Feet*
Bluebirds	5 × 5	8	6	1½	5–10
Robin	6 × 8	8	(1)	(1)	6–15
Chickadees	4 × 4	8–10	6– 8	1⅛	6–15
Titmice	4 × 4	8–10	6– 8	1¼	6–15
Nuthatches	4 × 4	8–10	6– 8	1¼	12–20
House wren	4 × 4	6– 8	1– 6	⅞	6–10
Bewick wren	4 × 4	6– 8	1– 6	1	6–10
Carolina wren	4 × 4	6– 8	1– 6	1⅛	6–10
Violet-green swallow	5 × 5	6	1– 5	1½	10–15
Tree swallow	5 × 5	6	1– 5	1½	10–15
Barn swallow	6 × 6	6	(1)	(1)	8–12
Purple martin	6 × 6	6	1	2½	15–20
Song sparrow	6 × 6	6	(2)	(2)	1– 3
House finch	6 × 6	6	4	2	8–12
Starling	6 × 6	16–18	14–16	2	10–25
Phoebe	6 × 6	6	(1)	(1)	8–12
Crested flycatcher	6 × 6	8–10	6– 8	2	8–20
Flicker	7 × 7	16–18	14–18	2½	6–20
Golden-fronted woodpecker	6 × 6	12–15	9–12	2	12–20
Red-headed woodpecker	6 × 6	12–15	9–12	2	12–20
Downy woodpecker	4 × 4	8–10	6– 8	1¼	6–20
Hairy woodpecker	6 × 6	12–15	9–12	1½	12–20
Screech owl	8 × 8	12–15	9–12	3	10–30
Saw-whet owl	6 × 6	10–12	8–10	2½	12–20
Barn owl	10 × 18	15–18	4	6	12–18
Sparrow hawk	8 × 8	12–15	9–12	3	10–30
Wood duck	10 × 18	10–15	3	6	4–20

[1] One or more sides open.

[2] All sides open.

ENTRANCES

Entrance holes for bird houses in most cases are placed near the top of the box, but if the inner side of the lumber used is dressed it should be roughened, grooved, or cleated to assist the young in climbing to the opening. Houses longer than high are comfortable and convenient, and seem to be liked by some species, particularly birds that do not have an inborn preference for the type used by woodpeckers or birds that are partial to old woodpecker holes. Perches at the entrances seem more of an assistance to enemies than a requirement for the occupants.

DIMENSIONS AND ELEVATION

The simplicity of construction of the single-room bird house does away with the necessity of detailed working drawings in most cases. Table 1 gives the proper dimensions for the various species and the height at which the boxes should be placed above the ground. The design may follow any of the types recommended in succeeding pages.

PRINCIPLES OF LOCATION OF BIRD HOUSES

E. H. Forbush, State ornithologist of Massachusetts, concluded from a statistical study of the subject that failure to attract feathered tenants may be attributed mainly to the following faults: (1) Entrance holes too small for the birds desired; (2) boxes put up in dense woods; (3) boxes placed in trees, and therefore accessible to birds' enemies, instead of on posts or poles; and (4) care not taken to protect birds nesting in boxes from their enemies. Three of these faults concern location—the second and third obviously, and the fourth indirectly, for it is manifestly easier to protect a bird house and its occupants if readily reached. "Easily accessible" means not beyond the reach of an available ladder; houses placed higher inevitably will be neglected. Houses on poles seem more acceptable than others to various birds, and this probably is because they impress the birds as being safer. Isolated trees can actually be made safe with tree guards, but perhaps they do not look so to the birds. Premises fenced against vermin probably will give such security that other precautions against enemies can be dispensed with.

To sum up, it would seem that houses should be fairly low, should not be put in dense woods, and seem more acceptable on poles than in trees. If possible, they should be placed with the opening away from prevailing winds.

It is not well to have a large number of boxes on a limited area, especially those designed to attract the same species. Birds insist on territorial rights, especially in competition with other individuals of the same species, and if houses are too close together conflicts between prospective tenants may result in none being occupied. The purple martin is our only gregarious nesting species that breeds in bird houses, and houses for colonies of these birds should be on poles well separated from trees or buildings. Tree swallows, however, are sociable and several individual boxes for them may be near together.

SUGGESTIONS FOR HOMES FOR VARIOUS BIRDS

Bluebird.—The bluebird is one of the least particular of bird tenants. Any of the types of nest boxes shown in Figure 1 will meet its needs when built to the proper dimensions and suitably located. Houses of rustic construction are also acceptable. Suggestions along this line may be found in Figure 2. The bluebird is partial to orchards, and nest boxes may be placed either in the trees themselves or on the posts of a near-by fence, provided measures are taken to prevent attack by cats. A location rather open and sunlit is preferable. The nest material, consisting mainly of dry grasses, is procured by the bird from natural sources.

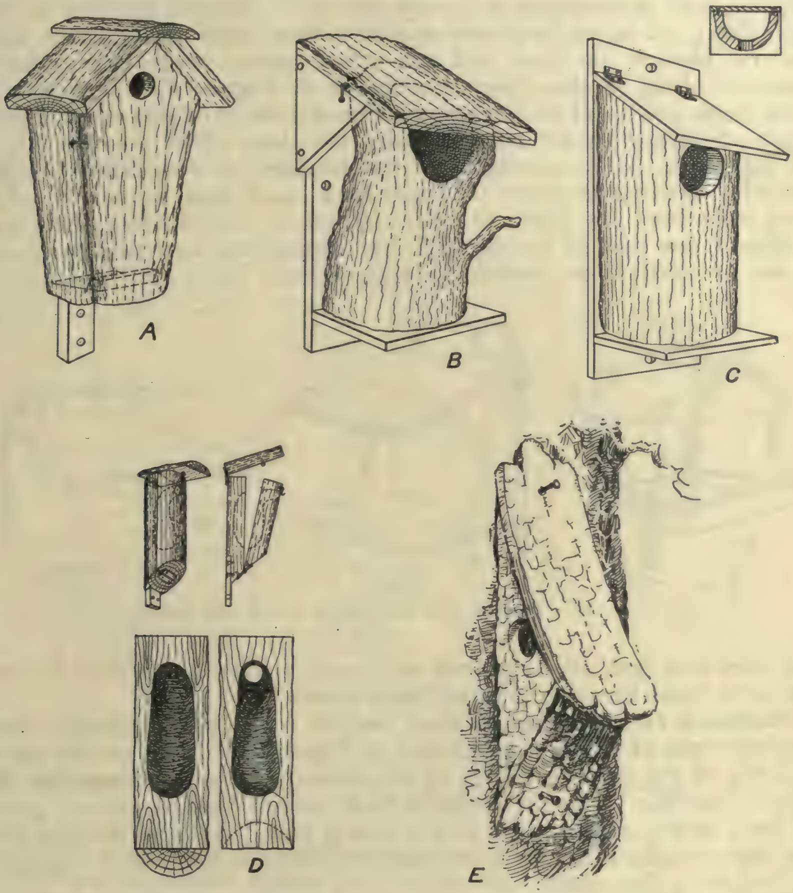

FIG. 2.—Rustic boxes. *A* has a removable front; *B*, a top held by two hooks; and *C*, a simple hinged top. In *D* there is a removable top which releases the front half of the cavity in the manner pictured. The principle embodied in *B* can be applied to the type shown in *E*, made of rough slabs

Robin.—Where such natural sites as well-formed crotches are lacking, robins do not hesitate to use nesting platforms erected for them (fig. 3). These should be either of weathered lumber or of rustic type. They should be placed in partly shaded spots along the main branches of trees or else in the shelter of the overhanging eaves of a shed or porch roof. The birds will gather their nesting material from natural sources, though in periods of dry weather they may be aided by wetting a spot of bare ground near by to serve as a source of the mud used in the foundation of their nests.

Chickadees, titmice, and nuthatches.—The needs of chickadees, titmice, and nuthatches are very similar. Being creatures of the woodland, all seem to prefer rustic homes built to simulate their natural abodes, but they will not refuse homes made of weathered lumber. Any of the types illustrated in Figure 1, when covered with bark and built to the proper dimensions, will answer the purpose. Suggestions for rustic houses for these birds may be found in Figure 2. Old orchards and the borders of woodlands are the favorite hunting grounds of these birds, and nest boxes placed in such situations are likely to be investigated. Chickadees often nest within a few feet of the ground, but nuthatches and titmice prefer a site of medium or considerable elevation. Food stations providing suet and nut meats placed on near-by trees are added inducements to these birds to take up their abode.

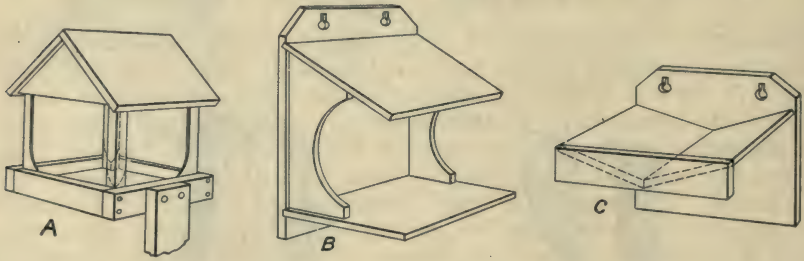

FIG. 3.—Nest brackets and shelves for robins and phoebes

Warblers and creepers.—Small bark-covered houses closely fitted to the trunks of trees, as suggested in Figure 2, *E*, may be attractive to birds of the nesting habits of the brown creeper and possibly the parula warbler. Brown creepers have nested behind curved pieces of bark tacked over the bark of a living tree. Natural nesting sites for these birds must be decreasing rapidly as the older shaggier-barked trees disappear.

Wrens.—House wrens and Bewick wrens are the least fastidious of our hole-nesting birds. Almost any sort of a cavity will meet their needs, though boxes of small size with a horizontal slot instead of a round hole for an entrance (fig. 4, *A* and *C*) are best. Wrens take equally well to houses of smooth lumber or of the rustic type. Longitudinal cavities (fig. 4, *A* and *B*) make picturesque and very acceptable homes. Security for nestlings against the house cat may be provided by the structure pictured in Figure 4, *A*, in which a passageway of variable length serves as an entrance to the nest lying below. Nest boxes of the dimensions recommended in Table 1 are better than larger ones, as it seems to be the desire of house wrens to fill with a jumble of sticks whatever cavity they select. The slot opening (fig. 4, *C*) permits the birds to carry in cumbersome material more readily.

Almost any shady or partly sunlit spot about the dooryard or orchard is agreeable both to the house and the Bewick wrens. A supply of slender twigs about 3 inches long handily placed will aid the birds in collecting nest material. An abundance of wren houses is desirable, as frequently the birds will build "dummy" nests or leave one or more unfinished nests before completing one to their liking.

The Carolina wren, a somewhat larger bird, may be offered houses with slightly larger openings. It is a less familiar species about the immediate dooryard, and consequently nest boxes placed at the border of woodlands or about brushy areas are more likely to be used.

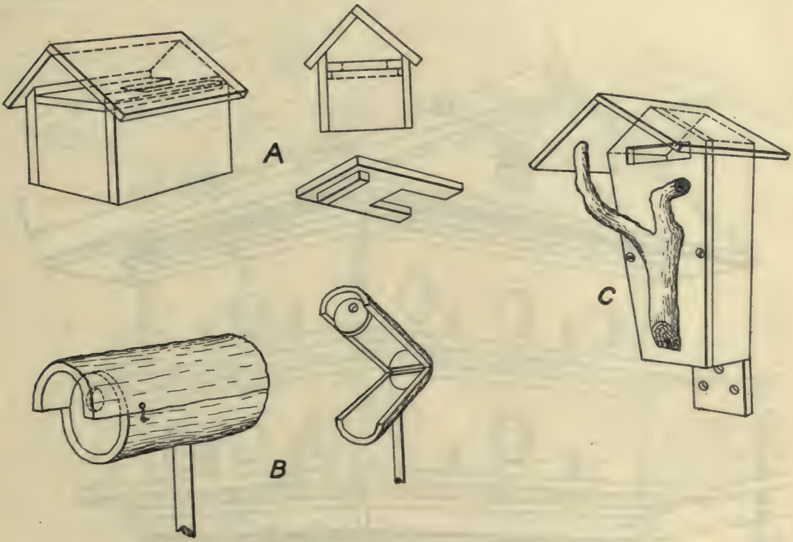

FIG. 4.—Nest boxes suitable for wrens. In *A* the nest cavity is made accessible by removal of a notched board

Catbirds and brown thrashers have been known to use such nesting shelters as those acceptable to robins (fig. 3).

Swallows.—Tree and violet-green swallows may be induced to forsake their natural nesting places in old woodpecker holes by the erection of nest boxes in suitable spots. Boxes of the types shown in Figures 1 and 2 will answer very well for these birds when constructed to the proper dimensions. A dead tree is an excellent site for such nests, and a number of boxes may be nailed to the same stub. Bodies of water hold a great attraction for swallows, and even a small pool in which they can bathe by dipping in flight will assist greatly in efforts toward establishing a colony in artificial homes. Barn swallows will avail themselves of the open or partly covered nest shelves shown in Figure 3 (*B* and *C*) when these are placed under the sheltering eaves of buildings. Long shelves on brackets capable of supporting a number of nests will satisfy the gregarious tendencies of these birds, and similar shelves under the roofs of barns or sheds will be utilized if entrance holes are provided in the gables. Eaves swallows may be encouraged to nest under overhanging roofs by providing a narrow shelf or cleat of rough lumber which will give them a place of attachment for their mud nests.

Purple martin.—The gregarious nesting habits of purple martins afford the builder of bird houses opportunity to employ his skill and ingenuity in construction, and in the matter of design he may let his fancy run riot. All too frequently, however, such fancies are allowed to overshadow the important factors of accessibility and coolness in the structure. Martin houses are always an attraction to English sparrows, and during the period of the year when the rightful tenants are not present the entrances to the nest cavities should be blocked or the houses taken down and stored. During the nesting season martins are apt to be successful in maintaining their property rights.

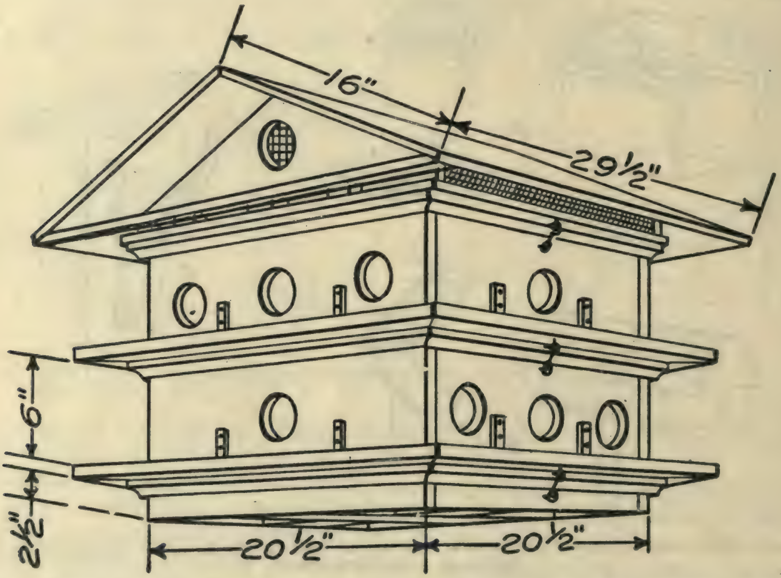

FIG. 5.—Martin house in which the foundation, roof, and each story are built as units of uniform lateral dimensions, permitting the addition of more stories as the colony grows and allowing ready access for cleaning. A central air shaft and an elevated roof, permitting the passage of air beneath the eaves, assure a cool temperature for the interior. A cove molding around the underside of the roof and each story holds the parts in alignment, and pairs of hooks and screw eyes fasten the units together

An idea that may be employed to advantage for a growing colony is illustrated in the house shown in Figures 5 and 6. Each story is made a unit, and the uniform size permits the addition of other stories as needed. A colony may be started in one story of eight rooms. Three stories, providing 24 rooms, will accommodate about as many martins as would ordinarily be desired in one colony. The roof, built to the same lateral dimensions, fits to the top story, all being held together by hooks and screw eyes. Cleaning is easily done by simply taking the house apart and dumping out the débris. The temperature within the house is kept down by air circulation through the passage formed by cutting out the floors of what would otherwise be central compartments. The roof, raised slightly above the top of the upper story, also permits the passage of air from the central shaft. The entire house with its support may be arranged for lowering in the manner illustrated in Figure 7, or, if the pole is set firmly in the ground, a ladder leaned against it will permit taking down the house section by section. Such a house of two stories built of soft pine will weigh about 65 pounds. Houses for martins should be situated in open spaces and are usually painted white with neat trimming of a darker color. As with swallows, water has an attraction for these birds, and a near-by pond or stream will increase the probability of establishing colonies.

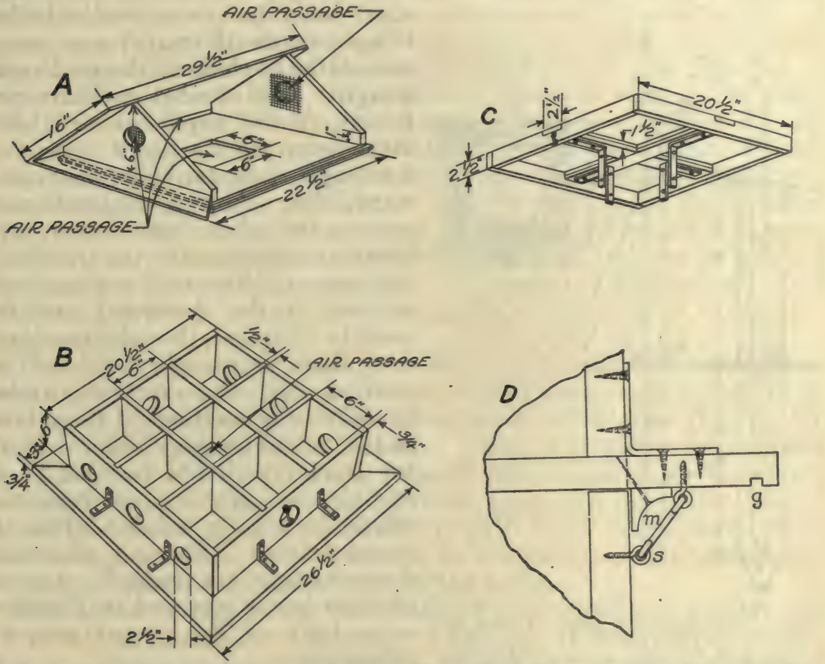

FIG. 6.—Details of the martin house shown in Figure 5: *A*, Roof with one side removed to show central air shaft. Air also passes through a 1-inch slot under the eaves and through two screened holes in the ends. *B*, One of the stories. The chambers are 6 by 6 by 6 inches inside dimensions, and the bottom of the central chamber is cut out. *C*, Foundation, in which the central cross is built up of double thicknesses of three-fourths-inch oak and the rest of the frame is of three-fourths-inch pine. Four heavy angle irons fasten this to the supporting pole. *D*, Detail of the porch when attached with angle irons; the molding *m* fits about the top of the lower story; the screw eyes and hooks *s* fasten the units together, and the groove *g* is made to prevent water from draining inward

The material for the walls and floors should be three-fourths inch thick, and that for the roof and interior partitions should be one-half inch. A light-weight roofing paper cut into shingles makes an efficient and neat roof covering. When facilities for gluing are available, the 3-inch porches may be made as extensions of the floors; otherwise they may be attached with angle irons as illustrated.

Song sparrows.—Although a thicket usually affords all the necessaries for their housekeeping, song sparrows may at times be induced to take up their abode in a more artificial location. A covered nest shelf, as in Figure 3, *A*, of weathered lumber, or painted a somber hue to harmonize with the background, is advised, and should be placed in the bird's natural haunts.

House finch.—The house finch takes readily to homes of simple design and construction. Any of those pictured in Figure 1 will answer the purpose. Orchards or dooryards abounding in shrubbery, where brilliant sunshine alternates with cool shadows, are the house finch's favorite habitat. Nest boxes may be placed in trees or on posts or may be attached to buildings.

Starling.—European starlings readily avail themselves of artificial nesting facilities, and in areas where they are common their needs and their persistent efforts toward taking possession of what they want must be given consideration. Houses made of lumber are just as acceptable to them as those of rustic design. Well-shaded sites are preferred, an old apple orchard being ideal from the starling's viewpoint. Although these birds are extremely wary, they show a marked preference for close association with human habitations during the breeding season. For this reason boxes erected in the dooryard are frequently occupied, though their presence there is usually rendered obnoxious by the rather careless housekeeping methods of these birds as the nestlings grow older. Boxes for starlings should be readily accessible for cleaning, an operation which is usually needed after the brood leaves. Two and sometimes three broods are reared. Any of the nest boxes pictured in Figure 1, when built of the proper size, are acceptable.

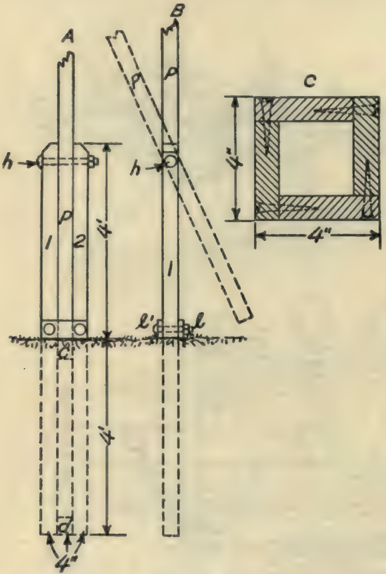

FIG. 7.—Martin-house pole. *A* and *B*: The supports (1 and 2) are 8 feet long and 4 inches square. They are held in alignment by the 4-inch blocks *c* and *d* and are buried 4 feet in the ground. A heavy bolt or section of pipe (*h*) serves as a hinge, and the base of the pole is held in position by the two hardwood blocks or iron plates (*l* and *l'*) bolted together. C: Cross-section of pole built of seven-eighths-inch hardwood. In case of large houses the pole and supporting posts should be 6 inches in outside diameter

Phoebe.—The phoebe, in common with certain other highly insectivorous birds, shows a liking for the vicinity of bodies of water. The broad timbers beneath a bridge are always an attraction, and when once a pair has taken up their abode in such a situation they are certain to return to it from year to year. Away from this favorite environment, nesting sites in the shape of mere shelves, as illustrated in Figure 3, *C*, may be offered. These may be placed on the wall just within the large open doorway of the barn, or higher along the rafters, and even outside beneath the eaves, where protection may be had from above. In more exposed situations nest shelters, such as are pictured in Figure 3, *A* and *B*, may be used.

Crested flycatcher.—Very different from the phoebe's are the needs of its relative, the crested flycatcher, whose original nesting sites were old woodpecker holes and natural cavities in trees. For these holes there may now be substituted boxes made of weathered or dull-painted lumber or fashioned from natural stubs or slabs. The latter types, when placed in typical situations, as in orchards, open woodland, or in trees in pastures, probably have a greater appeal than homes made of lumber. (See figs. 1 and 2.)

Woodpeckers.—Of all the woodpeckers, flickers respond most readily to the lure of artificial nest boxes. These birds have no hesitation in using boxes of painted or weathered lumber if other conditions are satisfactory. Boxes built to proper dimensions and conforming to any of the types illustrated in Figure 1 are acceptable. A roughened interior is preferable to a smooth one, as it permits the young to clamber up to the entrance as they grow older. A quantity of coarse sawdust, ground cork, or better, small chips, should cover the bottom of the box to the depth of 1 or 2 inches, in order that the birds may shape a cavity for the eggs. The chips also assist the birds in keeping the nest clean. Should these be neglected the birds are likely to mutilate the box in their efforts to produce their own supply. Flicker boxes should be placed above any immediately surrounding foliage. A dead stub makes an excellent support for the box and even a pole of the desired height will serve the purpose. The erection of flicker boxes may be used to prevent damage by these birds, especially the western form, which often persist in drilling holes into buildings in attempting to excavate a nesting site.

The red-headed woodpecker, although preferring nest holes of its own manufacture, has been known to occupy man-made homes, those fashioned from a natural stub being most acceptable (fig. 2, *D*). Bark-covered boxes (fig. 2, *A* and *E*) also will serve the purpose. As in the case of flicker houses, these should be placed above the immediately surrounding foliage. These birds are especially partial to oak groves. They are prone also to drill holes in telephone poles, which may cause the latter to break in windstorms. Supplying nest boxes will afford some protection to the poles.

The needs of the downy and hairy woodpeckers are similar and vary only in the slight difference of the size of nest cavity and entrance. Boxes of the types shown in Figure 1, covered with bark or made from natural stubs or slabs (fig. 2), are needed. In the bottom of each should be placed a small quantity of fine chips. A bit of open woodland, or even the orchard, will furnish a desirable site for their nests, and these should be attached to the trunk of a tree not densely shaded.

Owls.—Screech owls are not at all averse to using nesting facilities provided by man. Boxes of the types illustrated in Figure 1, when made of weathered lumber and stained a dull color or covered with bark, are acceptable. A grove, or, even better, an apple orchard, furnishes excellent sites for screech-owl boxes. The birds will supply the few bits of wood and feathers needed to form a nest. It should be noted that in some instances screech owls have proved very destructive to other birds during the nesting season, but this is not believed to be true of the saw-whet and barn owls.

The little saw-whet owl will take more readily to nest boxes fashioned from logs or those given a rustic appearance by a layer of bark (fig. 2). Chances are best for occupancy when the box is fastened to a substantial tree in an open grove.

The barn owl, now rare throughout much of its former range, may still be found in numbers locally. It takes readily to man-made structures, often frequenting barn lofts and towers on buildings for the nesting operations. A simple wooden box (fig. 1) of the proper dimensions will answer this owl's needs, and the birds will furnish the scanty nest material used. These boxes may be attached to the trunks of rather large trees or may be located about barn cupolas or in other little-frequented spots about buildings. For many years a pair of barn owls nested in one of the towers of the Smithsonian Institution, at Washington, D. C., in the center of an extensive park system.

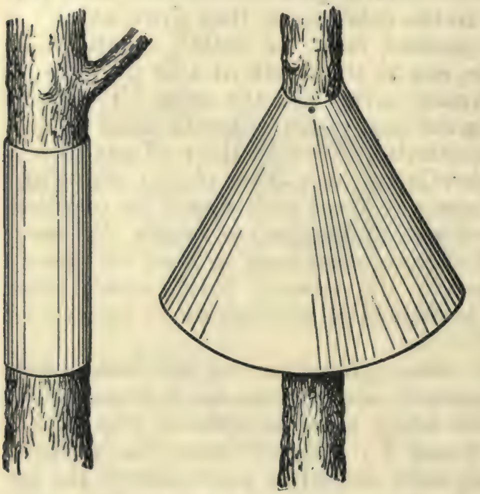

Fig. 8.—Tree guards

Wood duck.—With the continuous cutting of the older stands of timber, nesting sites for the wood duck are becoming increasingly scarce. To encourage the return of these beautiful ducks nothing more important can be done than the furnishing of nest boxes. These may be made of weathered lumber and fastened to the trunks of substantial trees. Any of the designs in Figure 1, if made to the proper dimensions, are satisfactory. Even an ordinary nail keg with a suitable opening has served well as a wood-duck abode. Lowland timber not far from a shady stream is the wood-duck's favorite breeding ground.

PROTECTION AGAINST ENEMIES

CATS

The house cat is one of the greatest obstacles in efforts toward increasing bird life in urban or suburban communities. The mere presence of a cat, regardless of whether it is or is not a habitual bird killer, has a demoralizing effect on nesting birds and may entirely defeat the most energetic efforts to attract and increase their numbers. Young birds just out of the nest are the easiest prey for the house cat and are liable to arouse the predatory instincts of the most docile and well-mannered. During the nesting season even the well-trained house cat must be kept away from the vicinity of bird houses, and the vagrant animal must be carefully guarded against or dealt with summarily.

A bird house placed on a pole or in a tree may be made inaccessible to cats by use of a sheet-metal guard. This may be either a cylinder about 18 inches long tacked closely to the trunk, or a cone, as pictured in Figure 8, placed high enough to prevent cats from springing from the ground and securing a hold above it. Iron pipes as nest supports are cat-proof in themselves. A far-overhanging and sloping roof close over the nest opening also is a partial protection against cats. In some situations, wire screen of a mesh large enough to permit the passage of the bird may be used to inclose the box in such a way as to prevent cats from reaching the nest. A more effective but expensive protection involves the use of vermin-proof fences built of a strongly woven wire of not more than 1½-inch mesh. Such a fence should be about 6 feet high with an outward overhang of 2 feet at the top (fig. 9).

Vagrant cats secure much of their food during spring and summer from bird life and had best be eliminated. In thickly settled regions poisoning or shooting are not recommended, but traps can be used effectively. A satisfactory cat trap is pictured in Figure 10. This consists of an inverted tight box (*a*) attached to a base board (*b*) with hinges (*x* and *y*). When set, the end of the box is elevated on a prop (*e*) which is connected by a stiff wire (*w*) with a light treadle (*t*). Bait is placed at *m*, and a little catnip in the trap will make it more enticing. When the trap is sprung the weight of the box, operating through a lever (*l*), removes the cork of a bottle (*p*) containing an ounce of carbon bisulphide. This, emptying into a receptacle (*r*) containing a wad of cotton batting, produces fumes that asphyxiate the cat humanely. Should one care to discriminate in the treatment accorded captured cats, the carbon bisulphide may be omitted. A small opening may be made in the box to furnish ventilation until the animal can be removed from the trap and dealt with as desired.

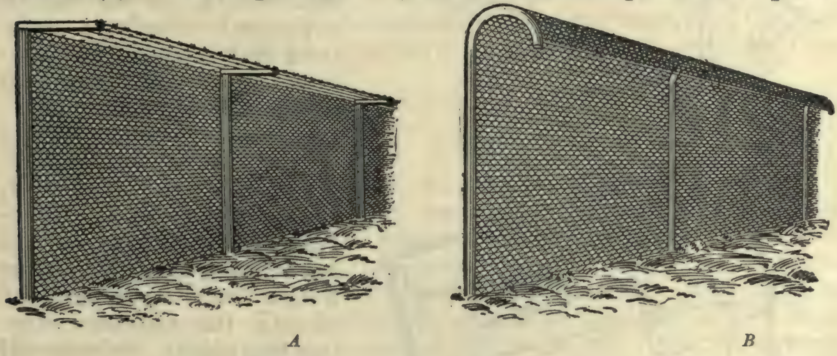

FIG. 9.—Cat-proof fences: *A*, With barbed wire; *B*, with overhanging netting

SQUIRRELS AND MICE

White-footed mice and squirrels, particularly red squirrels, at times become troublesome to nesting birds. Both eggs and young birds are eaten, and in search for these the squirrels frequently enlarge the opening to the nest box. The tree-guards illustrated in Figure 8 will keep squirrels from ascending isolated trees or posts, and circlets of sheet metal placed around entrance holes will prevent them from entering boxes having openings which they must first enlarge. Some observers assert that these metal circlets make it difficult for birds to obtain a footing at the nest hole, but this objection can be overcome by fitting them on the inside. It is well also to see that the circlets have no sharp edges or jagged projections to injure the birds.

Houses suspended on wires beyond jumping range from solid objects are immune to attacks by squirrels, cats, and mice, and are occupied by some birds. Occasionally squirrels that are particularly troublesome have to be shot.

ENGLISH SPARROWS

The ubiquitous English sparrow, a source of no little exasperation to those seeking to attract our native birds, also must be discouraged. Wrens and chickadees can be supplied with boxes having entrances less than 1¼ inches in diameter, too small for the passage of an English sparrow. Competition of the sparrow with other hole-nesting species can be prevented effectively only by a reduction in its numbers. Persistent destruction of their nests will discourage these birds, but at the slightest relaxation in vigilance they will reestablish themselves. When sparrows have taken up an abode in a bird house the female may be caught by closing the entrance during the night. Solution of the difficulty, however, lies in an aggressive campaign against the sparrow, carried out preferably during the winter months, with the object of materially reducing or eliminating the breeding population for the next season.[9]

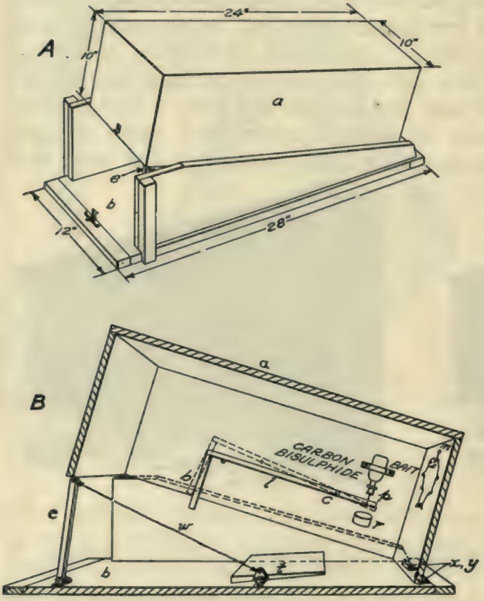

FIG. 10.—An effective cat trap: *A*, The trap set; *B*, trap with near wall and side board removed to show arrangement of treadle release, bait, and container for liquid fumigant.

EUROPEAN STARLINGS

The European starling presents a somewhat similar problem in the eyes of those who look upon the bird mainly in the light of its transgressions against our native species. This bird is extremely persistent when engaged in a controversy over the ownership of a nesting site and seldom fails to be the victor. Its insectivorous habits, however, place it in the van of those birds which are considered effective controlling agencies of ground insect pests. When not too abundant, starlings are a distinct asset about the garden, and it will pay to provide nest boxes for their use (see p. 14).

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[9] Methods of combating these birds by trapping and poisoning are to be found in Farmers' Bulletin 493, "The English sparrow as a pest."

OTHER ENEMIES

Red-headed woodpeckers, blue jays, purple grackles, magpies, crows, and other birds occasionally destroy eggs and young to an obnoxious extent. When the offending bird is not protected by Federal or State laws, the remedy is elimination by shooting.

SANITATION OF BIRD HOUSES

The desirability of having all bird houses built so as to be readily opened for inspection has been noted previously. This feature is a necessity in regions infested by the gipsy moth, as all possible hiding places for the egg masses of this species must be examined. The tussock moth and other insect pests also may place their eggs or cocoons in bird houses; and it will be to the advantage of the human owner as well as of the birds if the boxes are regularly inspected and cleansed of all intruders, which include also mud-daubers and paper-wasps, bees, mice, and flying squirrels. The insects can be stupefied by fumes of carbon bisulphide, carbon tetrachloride, sulphur, ordinary smoke, or the like, and disposed of as desired. The small rodents can be dumped out unceremoniously in the hope that the birds will take possession before they return; or, if it seems necessary, they can be killed.

The houses should be repaired and cleaned just before the nesting season and inspected periodically so long as birds are about. Birds are subject to parasites, some of which, as fleas, bird lice, and bird flies, are usually mere nuisances; but others, as the larvae of certain flesh flies, are a serious menace to nestlings and sometimes are so prevalent as to cause general mortality over a considerable area. Houses infested by these pests may be treated with liberal applications of derris or pyrethrum powder, special attention being given to the nest. The feathers of nestlings also can be powdered. In case the fly larvae are discovered in time, any that are actually attached to the nestlings may be removed and a mild antiseptic applied to the wounds.

It is advisable to clean nest boxes immediately after broods have left, even if the parent birds show signs of using the house for another family. Old eggs and dead nestlings will thus be gotten rid of and the parasites of the birds kept down. The material removed should be placed on a paper and burned. After cleaning, spray the interior well with cresol to destroy any pests that may have been overlooked. On the whole, clean nest boxes have a better chance of being occupied, and certainly the prospects for rearing the next brood are improved.

So far as bird parasites are concerned sanitation of the houses can be profitably supplemented by ample provision for water and for dust or sand baths.[10] These are nature's means of keeping down body vermin.

PROVISION OF NESTING MATERIAL

The home making of birds can be aided in many cases by the provision of nesting material. Natural materials of some sort are not so abundant as formerly, and substitutes are welcome. Rags, ravelings, and twine can be used by many birds, but short pieces only should be furnished in order to avert danger to the birds from tangling. Excelsior, straw, hay, cotton, and even hair (as used in plastering) and feathers may be supplied. A convenient way of exposing these to the birds, which at the same time prevents waste, is to use holders similar to those in which suet is placed for winter feeding; an ordinary wire broiler is excellent for the purpose. If thoroughly wet clay be made available, it will be eagerly taken by robins, phoebes, and swallows.

---

[10] For information on bird baths see the Farmers' Bulletins mentioned in footnote 2, page 2.

NESTING THICKETS

Besides the birds that build their nests on the twigs or limbs of trees, in cavities of the trunk, or in nest boxes placed in trees, there are others that can be helped by providing thickets similar in character, if not in size, to those they naturally frequent. Density seems to be the most desirable feature of a bird thicket, as it gives protection from enemies. Shrubs interlaced with vines are effective and rather easily provided. In their earlier years the shrubs should be pruned so as to form numerous crotches that will support nests. The kinds of plants to use depend upon the locality; but those producing fruit eaten by the birds are most desirable, as they serve a double purpose. Recommendations as to the species suitable for various sections of the United States are contained in Farmers' Bulletins mentioned in the footnote on page 2.

ROOSTING SHELTERS

Compared with those interested in bird protection in central Europe, Americans have sadly neglected one important matter in bird conservation—the provision of suitable roosting quarters, which have great value during periods of cold weather. The nest boxes left up throughout the year fill this need in part, but much more can be done. The removal of thickets and hollow trees in which numbers of birds formerly sought refuge from the elements and from enemies has greatly increased the need of warm and safe quarters for inclement nights. A large hollow tree partitioned into apartments may become the haven for a number of birds belonging to several species, as was demonstrated some years ago in an interesting manner when a well-known naturalist constructed an artificial hollow tree, to which he would often repair to study the ways of the nightly visitors. Although nothing so pretentious as this is necessary to fill the needs of roosting birds in a community, there is no question that proper housing will greatly reduce the winter mortality among them. Woodpeckers, titmice, nuthatches, chickadees, wrens, starlings, and owls will readily avail themselves of such shelters, and doubtless many species not hole nesters would use such cavities as roosting places. The benefits accruing from the provision of roosting shelters may not be so apparent as in the case of nest boxes, but they are none the less real. Several of our woodpeckers, chickadees, nuthatches, and titmice now have the habit of using old nests for winter quarters, and no doubt they will utilize nest boxes or roosting houses for the purpose, especially such of the latter as are constructed for individual birds.

Roosting boxes should be waterproof and firmly attached to their supports. Placed at an average height of 8 or 10 feet, with a southerly exposure for the entrance, they will meet the needs of most birds. They may well be located in a sheltered spot to give added warmth, and should have the customary cat and squirrel guards in areas where these animals are apt to be troublesome. Contrary to the principles of nest construction, the entrance need not be near the top. A lower entrance (fig. 11), in fact, will have a tendency to let what warmth accumulates rise and be retained at the top. The perches within should be arranged so that none is directly over another. Such roost boxes may be of variable size, but one 8 or 10 inches square and 3 feet long will provide shelter for several small birds. Two suggestions along this line are given in Figure 11. An entrance hole 3 inches in diameter will meet the needs of the smaller birds, while owls are better cared for by supplying individual boxes with larger openings. Sanitation should follow the lines laid down for nest boxes (p. 19).

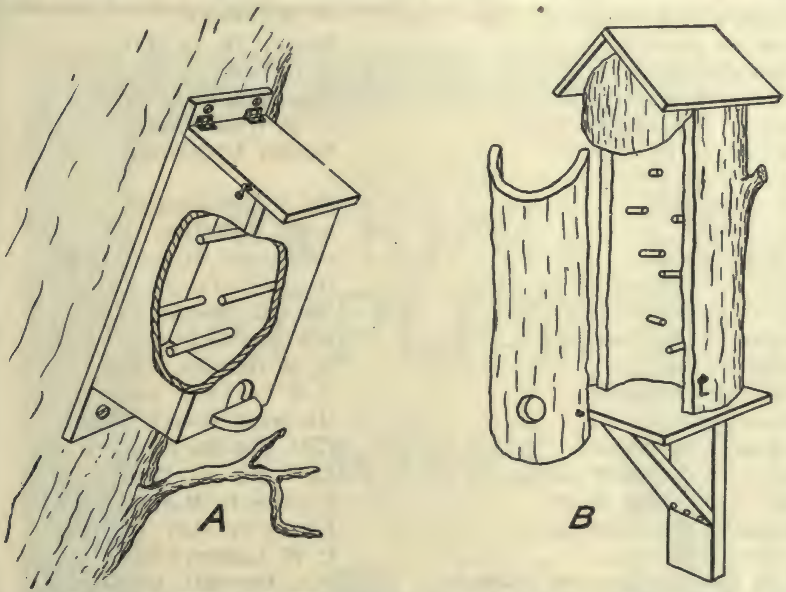

FIG. 11.—Roosting shelters that will serve as a much-needed protection during severe weather, particularly for winter birds

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June 18, 1925

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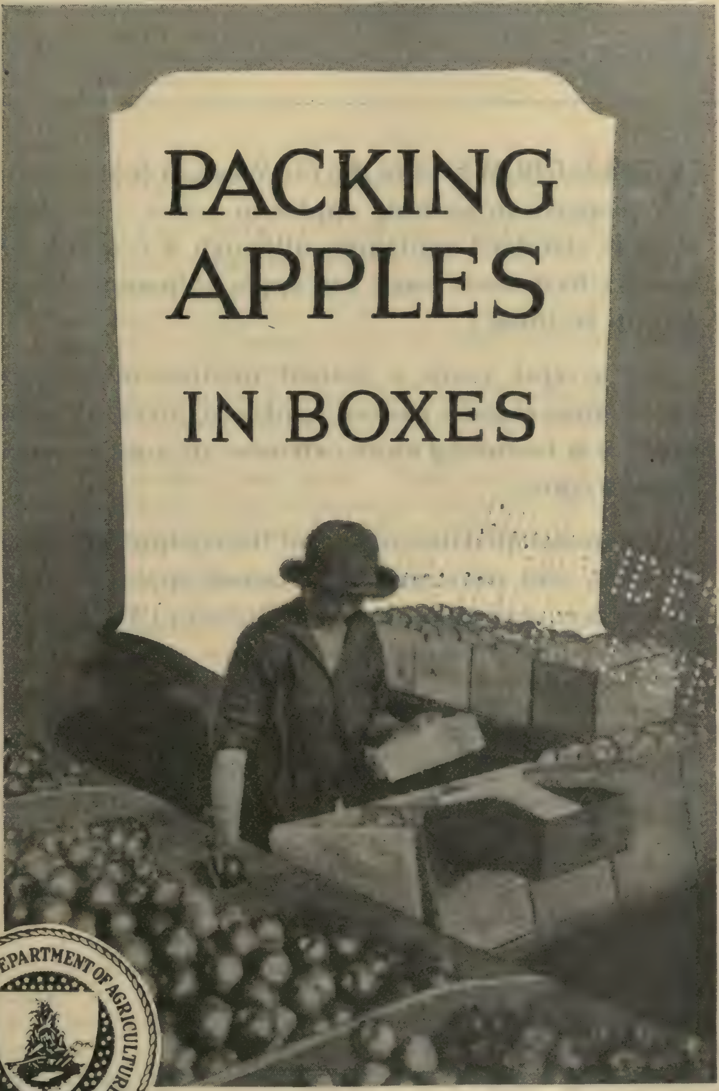
FARMERS' BULLETIN No. 1457

PACKING APPLES IN BOXES



1862 1889

APPLE GROWERS in the far Western States were pioneers in packing apples in boxes. The box is their standard container, although a few bushel baskets have been used for apple shipments from certain sections.

For several years a limited number of eastern apple growers have packed apples in boxes, and the practice is becoming more extensive in some eastern apple sections.

A more detailed description of the equipment, management, and construction of boxed apple packing houses is contained in Farmers' Bulletin 1204, Northwestern Apple Packing Houses.

WASHINGTON, D. C. Issued August, 1925

PACKING APPLES IN BOXES

By RAYMOND R. PAILTHORP and FRANK S. KINSEY, *Marketing Specialists, Bureau of Agricultural Economics*

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DEVELOPMENT OF WESTERN BOXED PACKING

THE WESTERN BOXED-APPLE INDUSTRY has developed to its present commercial importance mainly within the past 25 years. For the 6-year period ended in 1899 boxed apples constituted less than 5 per cent of the total production of the United States. For the 6-year period ended in 1923 boxed apples averaged about 30 per cent of the total.

Rapid development of domestic and foreign markets, in the face of the keenest competition from the old established apple regions, has been due in large measure to the reputation gained and maintained by the western box pack. Eastern districts still retain the barrel as the standard apple package, but there has been a gradual extension of western methods into this territory.

COMMUNITY PACKING HOUSES

A well-arranged and well-equipped packing house is necessary for efficient packing of boxed apples. A community packing house is especially desirable in a section that is beginning to pack apples in boxes if a group of growers by joining forces can finance the erection of a modern packing house. In such a house it is possible to perfect an organization of trained men to bring the grading and packing operation to a uniformly high standard. The cost of packing in such a house may not be so low as when the work is done by the individual, but it can usually be done more thoroughly and a more uniform pack is assured as inspection and responsibility are centralized.

CONSTRUCTION OF PACKING HOUSES

A convenient point either in the orchard or along a railroad siding is selected for the packing house. If packing and storage rooms are parts of the same building, the same building materials can be used in construction. Wood, concrete, brick, or tile is used, the choice of material being determined by cost and fire risk. The storage should be insulated and all illumination furnished by the use of artificial light. The packing room does not need insulation but often requires heating for the health and comfort of the employees.

Efficient work in the packing room is possible only when the room is properly illuminated at all times. Hipped-roof skylights installed over the sorting tables and side windows placed about 5 feet up the wall in sufficient numbers to light the interior thoroughly provide the most satisfactory method of lighting. (See fig. 1.) Where the house is constructed with a loft, light shafts or wells are used to admit light and to concentrate it over the sorting tables. White paint is applied to the ceiling and walls to intensify whatever light is available. Electric lights are necessary for use at night and on very dark days.

EQUIPMENT

The kind and amount of equipment for packing depend upon the size of the house, quantity of apples to be packed, and the preference of the management.

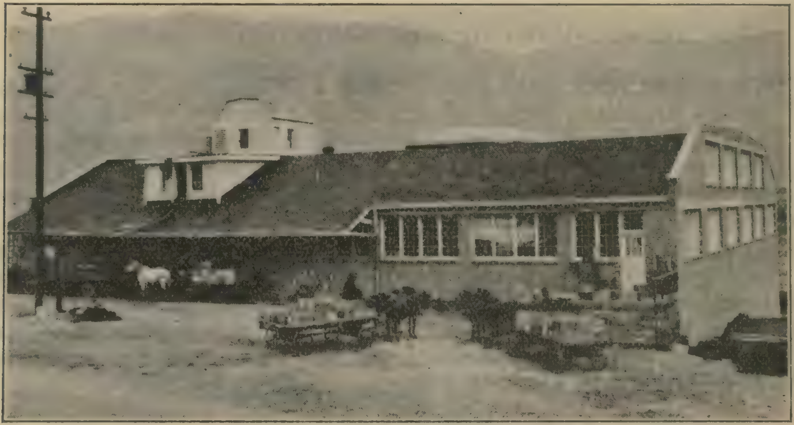

FIG. 1.—A community apple storage and packing house with adequate light in the packing room

HAND TABLES

Grading and sizing by hand are especially adapted for use in small packing houses, where the quantity of apples to run is small, and in large packing houses where many small lots of fruit must be packed at the same time. Through the use of hand tables it is easier to prevent stem punctures and slight bruises, and the expense of a machine is saved. As the fruit is sized by the packers, experienced and conscientious packers must be employed in order to put out a uniform-sized product.

In packing with hand tables the apples are sorted for grade directly into bins or compartments upon a packers' table from which they are packed into the boxes by the packer. The equipment used for hand operations consists of a sorting table, a packers' table, and a packing stand, all of frame construction. Where packers' tables as large as 4 feet wide and 8 feet long are used they should be constructed with padded solid bottoms which slope slightly toward the packers, the lower side being about 3 feet from the floor. If canvas or burlap is stretched for a top, it is likely to sag, with the result that the apples collect in the middle of the table at an inconvenient distance from the packer. A crack an inch or so wide is provided at the lower end of the table to allow broken stems and other trash to fall through. This table is furnished with a padded flange around the sides 4 to 6 inches high. The padded partitions should be made movable so that the compartments for the various grades may be enlarged or contracted according to the needs of the lot of apples being run.

Apples are sorted and placed upon this table either directly from the orchard box or from a sorters' table about 4 feet long and 2 feet wide attached to the upper side of the packer's table. The sorters' table, which may also be square or somewhat fan-shaped, tilts slightly toward the packers' table, has sides about 4 inches high, is open at the lower end, and has a bottom made of padded slats to prevent bruising of the apples and to allow trash to fall through the cracks, or it may have a solid padded bottom. To reduce injury from careless dumping a canvas apron is attached to the edge of the sorter's table and placed over the box to prevent the apples from pouring out of the box with a rush. This unit will accommodate 2 sorters and 2 or 3 packers. A packers' table 5 feet long, 26 inches wide is preferred by some growers, since it eliminates the opportunity for a long throw by careless sorters and permits the packer to reach conveniently the apples at the far side of the table. Such a table will accommodate one packer and one or two sorters. Tossing the fruit should be discouraged, as it always results in more or less bruising.

SIZING MACHINES

Machines are used very extensively for sizing apples prior to packing (fig. 2). The advantages of the mechanical sizer are convenience and speed in sorting and boxing the crop and the uniformity of size which can be secured in any one box. Since the apples are sized for the packer, more inexperienced labor can be employed than in packing from hand tables where the fruit is sized by hand. The disadvantages are the expense of the equipment and the danger of punctures and slight bruises to the apples. Such packing injuries can be eliminated through the proper supervision of work on hand tables. Given the same excellent supervision to both hand tables and sizing machines, fewer injuries will occur when using the former. With poor supervision, however, more injuries are likely to result when packing on hand tables.

Sizing machines are provided either with a canvas sorting belt or with a roller sorting table composed of parallel wooden rolls wound in a spiral manner with sash cord. A feeding hopper or dumping table receives the fruit at one end of the machine. As it passes over the sorting table it is graded by hand and carried on various belts to the sizing unit, which delivers the apples into separate bins for packing. Most machines are about 6 feet 2 inches wide and vary from 26 to 52 feet in length, depending upon the make and capacity.

GRADING BELTS

With the improvement of mechanical sizers the use of grading belts has diminished in the boxed-apple districts, probably because most mechanical sizers have a larger output and because less experienced packers can be employed. The grading belt consists of an endless canvas belt about 22 inches wide, run over a drum at each end approximately 15 inches in diameter. The belt is supported by a smooth board surface, and 2-inch strips are used to prevent apples from rolling off. The belt and board surface are supported by a wooden frame. The height of the belt is about 42 inches, and the usual width is 26 inches, including the frame. The fruit is fed to the belt by a short, sloping dumping table. The belt carries the ungraded fruit before the sorters, by whom it is sorted and distributed to various bins.

Excessive stem puncturing and bruises often occur, for the bins are usually large, allowing an accumulation of a large quantity of fruit and offering an opportunity for a long throw for the sorters. Grading belts are open to the objection mentioned for hand tables in that the packer does his own sizing and experienced packers must be employed to secure a uniform size in each box.

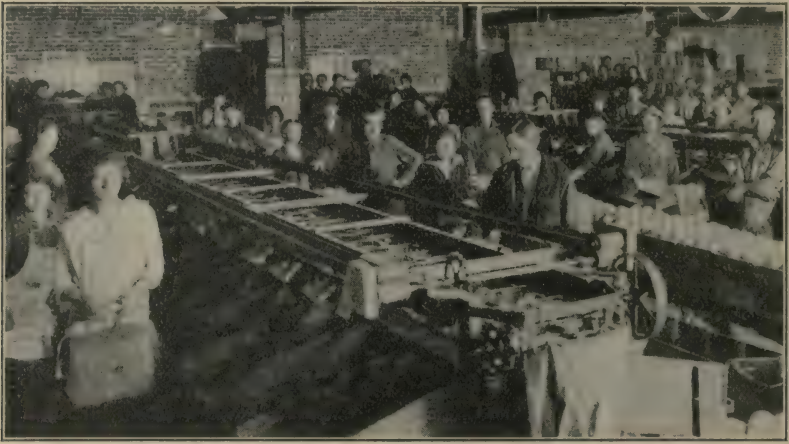

FIG. 2.—Sorting and packing with sizing machines

PACKING STANDS

The same general style of packing stand or box rack can be used for holding the boxes which are being packed, whether the packing is done from bins of a table or a machine. This stand is wide enough to accommodate the length of the box and long enough for as many boxes as are desired for packing into at the same time. The side next the packer is most convenient at such height that when the box is in place his fingers will just reach the bottom of the end of the nearest box. In order that the apples will stay in place when put in the box the stand is constructed about 6 inches higher at the back than at the front next the packer.

In packing from hand tables and grading belts when the fruit is not sized, either the packer has enough boxes in process of being packed so that he can pick up any apple nearest him and place it in one of them, or else he picks from the table all the apples of one size which he can see or which will fill one box, and then packs all of another size. In the former case the packer may use a stand long enough to run five or six boxes at the same time and even then, perhaps, lay aside the smallest and very largest apples.

When packing from bins of a sizing machine packers use a stand holding one box. It is often possible to pack more than one size from each bin, but such a practice is not customary except in packing from bins containing very large and very small sizes.

PAPER HOLDER

A holder or hod (fig. 3) is used for paper or wraps. Two angle hooks are screwed into one edge and a brace is attached underneath the hod to hold it in position. It is attached to the packing stand at the side of the box nearest the packer, or it is hooked upon the upper head of one of his boxes. A "paper needle," which bears upon one edge of the paper with a spring, is attached to the side of the hod and holds the paper in place besides preventing more than one sheet being picked up at once.

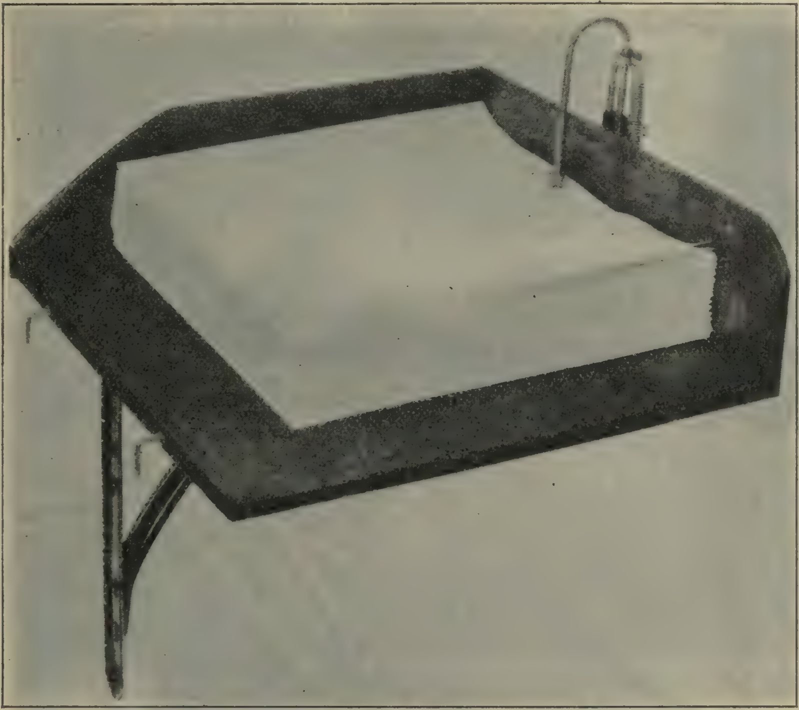

Fig. 3.—Paper hod used to hold supply of wraps for packing

PAPER RACKS

To prevent waste of wraps racks of some sort are necessary so that the supply will be handy for the packers. These racks are usually placed underneath the bins, each size of wrap being located adjacent to bin where used. In some cases racks may be placed on the walls along the sides of the packing room.

CONVEYING EQUIPMENT

Gravity conveyors are used in most packing houses, as such equipment has proved essential to the economical handling of boxed apples. Sections of conveyors are used in unloading loose fruit from the orchard wagon and in handling the fruit from the loose-fruit storage to the sorters, from the packers' stands to the lidding presses (fig. 4), and from there to the packed-fruit storage or into the car for shipment.

A few houses are equipped with moving belts and gravity conveyors, which handle the boxes throughout the packing house and storage.

Inclined belts, provided with cleats to prevent the boxes from slipping or upsetting when traveling up or down a relatively steep pitch, are used for lowering or elevating the fruit. Such belts travel over and are supported by an iron-covered or plain smooth board. When the pitch is very steep or economy of space is desired, inclined elevators carrying the box in an upright position may be purchased. Such elevators, which can be reversed, can be operated at an angle of 30° from the perpendicular.

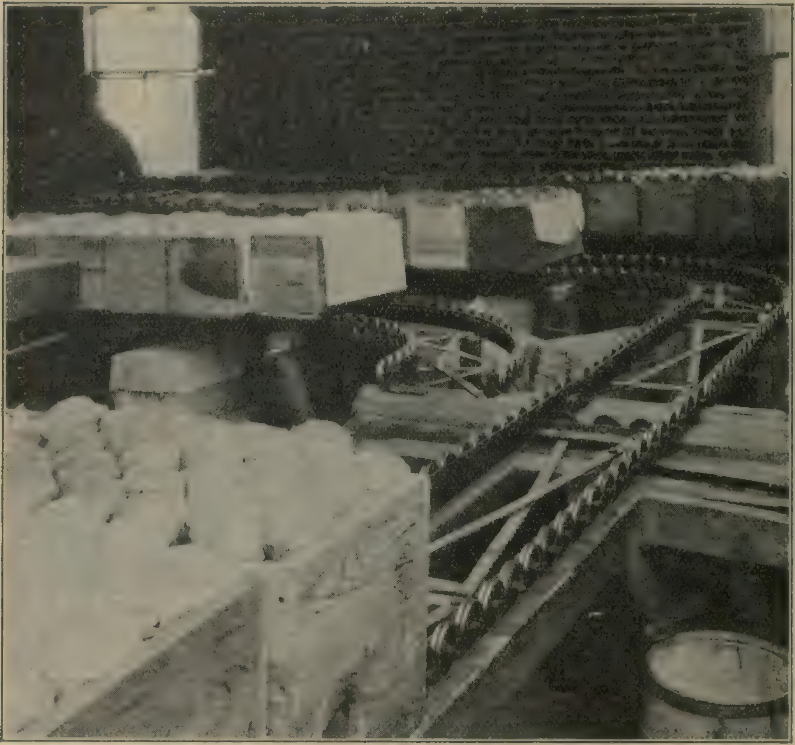

FIG. 4.—Moving packed boxes to the lidding presses on gravity conveyor

Two-wheel hand-grip trucks of a special design are used for moving stacks of boxed apples. Most of the houses use a few such trucks, although the greater part of the handling in the larger packing houses is done on gravity conveyors and belts.

LIDDING PRESSES

After packing, the covers are drawn into place by a lidding press and nailed. Of the several types manufactured those constructed of iron or steel are most satisfactory, as they can be used for several years without repairs. In Figure 5 is shown a desirable type of lidding press. At the right is an unlidded packed box as it comes from the packer. On the press is a box with lid drawn into place and ready to receive the cleats. On the left are lidded boxes ready to be conveyed to storage or car. A shelf on the press holds the nail stripper, hatchet, lids. and cleats.

BOX-MAKING BENCH

A bench upon which boxes are made up is necessary equipment. Some growers prefer to purchase an iron form mounted on a wooden bench, such as is shown in Figure 6. Many growers use a homemade bench similar to the one illustrated in Figure 7 (A–B). Thirty-two fivepenny cement-coated box nails are used in making up each box. Four nails are driven through each end of the pieces which form the top, bottom, and sides. In nailing the top or bottom, a cleat is placed at each end and the nails are driven through cleat and top or bottom. Boxes are usually made up well in advance of the packing season.

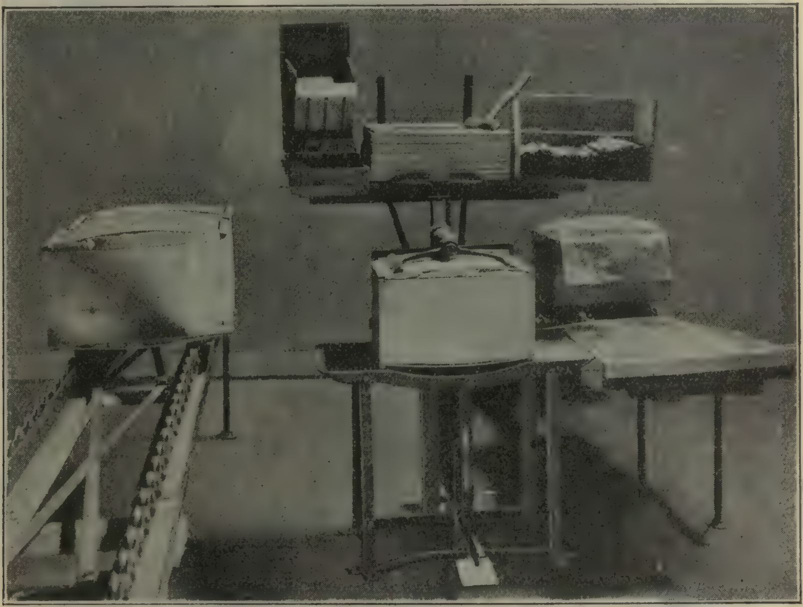

FIG. 5.—A desirable type of lidding press showing arrangement of nailer's equipment and supplies, and boxes in process of lidding

MISCELLANEOUS EQUIPMENT

An automatic nail stripper (fig. 8), which delivers nails in convenient arrangement for holding between the thumb and first finger, is indispensable if nailing operations are to be done speedily. Powdered soapstone is often poured over the nails so that they will slide more easily into the grooves on the face of the stripper.

Box hatchets similar to a lather's hatchet are used in making up and lidding boxes and for nailing strips of lath between stacks of boxes when loading cars.

When boxes are exported they should be wired or strapped (fig. 9) at each end just inside the cleats to prevent breakage in transit and in handling at shipside. Provision is usually made at docks for doing the work, but many packing houses that conduct an extensive export business find it profitable to buy a wiring or strapping machine and do the work at the packing house.

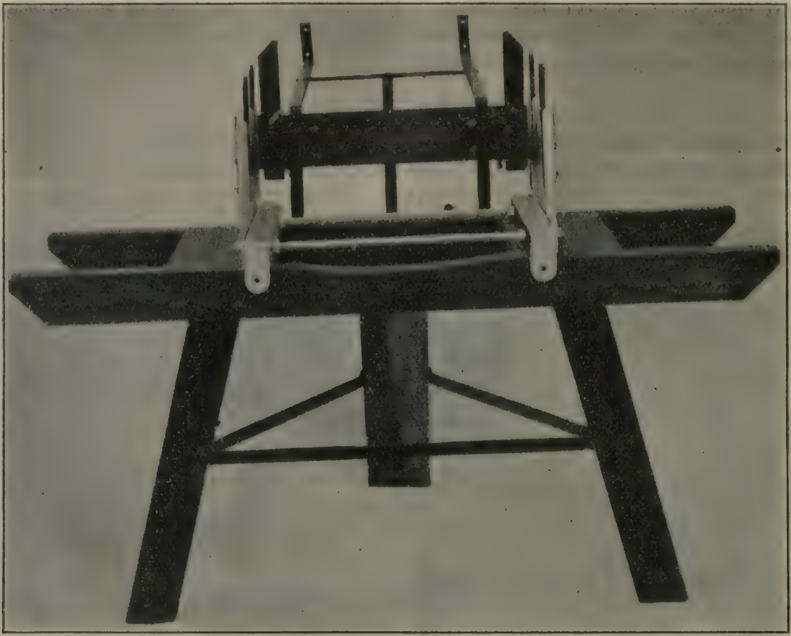

FIG. 6.—Iron form for box making mounted on a wooden bench

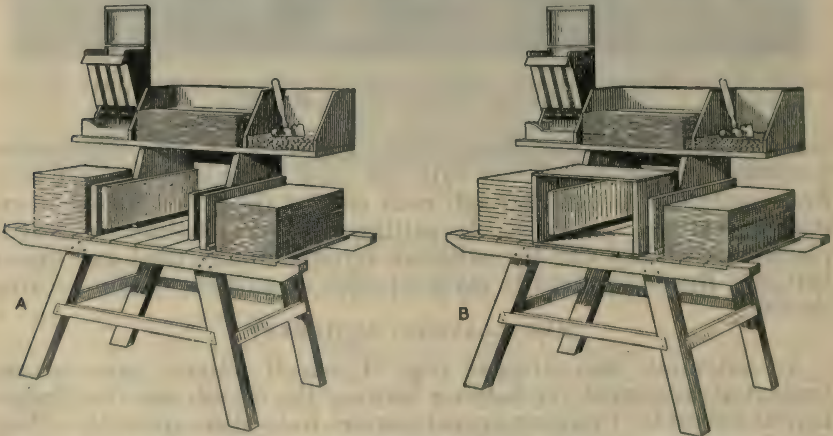

FIG. 7.—A wooden box-making form and bench showing convenient arrangement of box materials and nail stripper, before ends are placed in position for nailing, and with ends in place and one side nailed.

SUPPLIES

APPLE-BOX MATERIALS

The apple box which is standard in the boxed-apple section of the Northwestern States and California is 18 inches long, 11½ inches wide, 10½ inches deep, inside measurements, and contains 2,173 cubic inches exclusive of the bulge, or 23 cubic inches more than the struck United States standard bushel. The bulge usually is figured as containing 150 cubic inches.

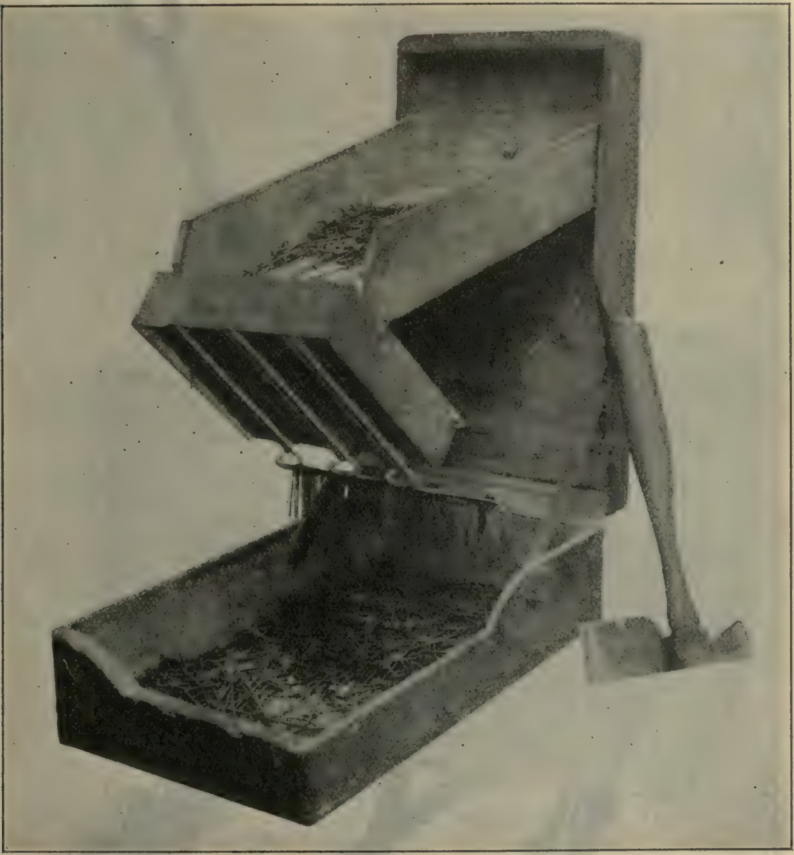

FIG. 8.—Nail stripper and hatchet for nailing operations

The following are specifications for apple-box shooks:

Ends, ¾ inch or ⅞ inch by 10½ inches by 11½ inches, 2 pieces	20 to bundle.
Sides, ⅜ inch by 10½ inches by 19½ inches or 19¾ inches, 2 pieces	40 to bundle.
Top and bottoms, ¼ inch by 5½ inches by 19½ inches or 19¾ inches, 4 pieces	100 to bundle.
Cleats, ⅜ inch by ¾ inch by 11½ inches, 4 pieces	100 to bundle.

Spruce and pine are two common woods used and make very satisfactory boxes. All box material, except the cleats, should be surfaced at least on one side. The cleats are soaked before nailing to prevent splitting.

WRAPPING PAPER

It is advisable to wrap all boxed apples, except the very small sizes (198's or smaller), which are often placed without order in the boxes and are known as jumble packs. If small apples are exported, they are usually wrapped. The wraps make it easier to pack, aid in protecting the apples from bruising and in preventing the spread of decay, keep the fruit clean, make a more sanitary package, and indicate to the buyer that care has been exercised in preparing the fruit for market.

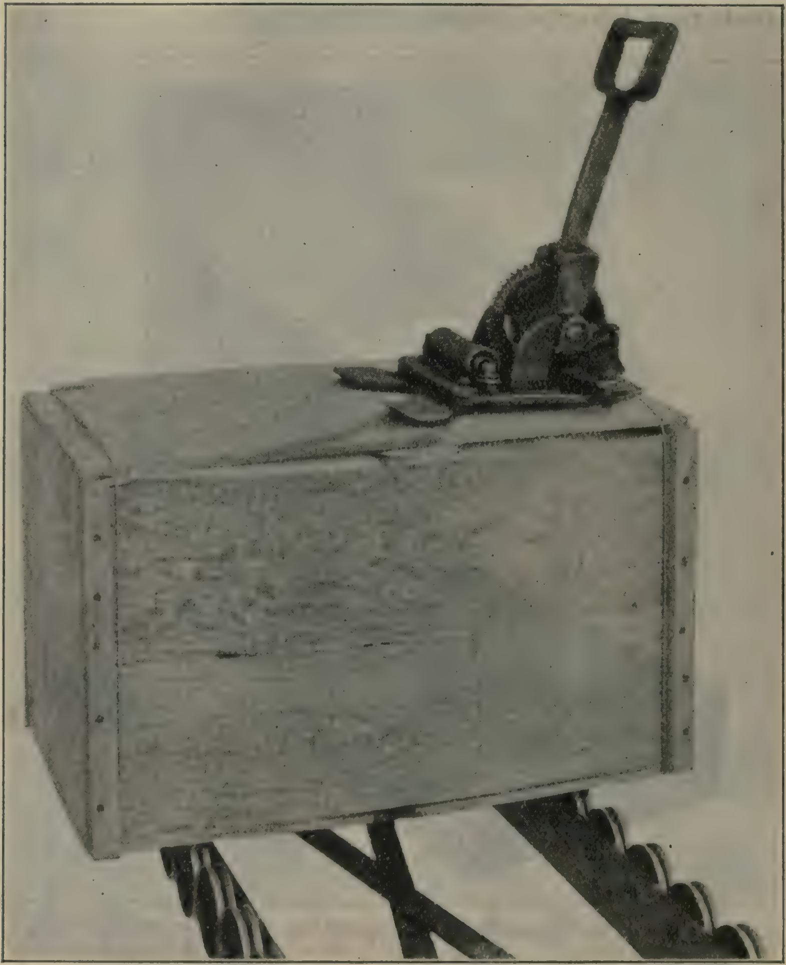

FIG. 9.—Wiring a box for export

Twelve or fourteen-pound paper, smooth or glazed on one side, is used for wrapping apples. The wraps are shipped in bundles of about 50 pounds. Some are sold with a specified number of sheets to the bundle. Oiled wraps are now extensively used on varieties to be stored, as a preventive against scald. For apples of sizes 56 and larger, 12 by 12-inch or 14 by 14-inch wraps are used, 11 by 11-inch for sizes 64 to 80, 10 by 10-inch for sizes 88 to 113, 9 by 9-inch for sizes 125 to 180, and 8 by 8-inch for sizes 198 and smaller.

LINING PAPER

Lining paper for the boxes is used with the better grades of apples. Two sheets 17½ by 26 inches are required for each box. Some packing houses use white, blue, and pink liners for different grades of apples. Thirty-two pound newsprint or 20-pound sulfide paper is generally used for this purpose. The latter costs more per pound but is stated to cost no more per box because there are more sheets to the pound.

STAMPS

Each packing house should have a supply of rubber stamps and ink pads. After the apples are packed, but before the boxes are lidded, the variety, grade, numerical count, and minimum net weight are stamped with either violet or purple ink on the end of the box directly above the label. Some shippers also include the packer's number and the grower's name. The stamping is done by the packer, the lidder, or by some one whose whole time is devoted to this work.

Many packing houses use a self-inking stamping machine attached to one side of the lidding press and operated by the lidder. The number and grade stamps are on rubber bands stretched over rollers, and are set by means of knobs which turn the rollers. Stamps for variety, grower's name and address and weight are held in place by spring clips and may be quickly changed. The stamps are all in straight alignment and the lettering is distinct.

LABELS

The labeling of boxes has become a standard practice in the boxed-apple section. Packing houses should have a supply of labels using different color combinations for the various grades to be packed. A blue label is commonly used for the extra fancy grade, red for the fancy grade, and white for the C grade. A good label is neat, simple, attractive, and should indicate the character of the product. It should be large enough to cover the end of the box to within 1½ or 1¾ inches of the top, this space being required to insure that the stamping will not be covered by the label. Only the best grade of paste should be used, and it should be remembered in applying the labels that if the paste touches the stamp marks the ink will run and make them indistinct. Labeling can be done in either the storage or car. If the boxes will remain in storage long enough for the labels to dry, the work should be done there; when the work is done in the car it often results in torn labels and is more expensive, because the labeler is in the way of the car loaders and is often idle when the loaders are stacking the boxes.

SKETCHING THE OPERATIONS

To line a box, a sheet of paper is placed in such a way that it reaches about two-thirds across the bottom, comes up the side, and is bent back over the outside of the box. In a like manner a second sheet of lining paper is placed on the opposite side of the box and overlapping the first on the bottom. The bottom corners of these sheets often tear when the lid is forced into position for nailing unless the packer has made folds in the papers at these points. Before placing a lid, the loose ends of the paper are brought together over the top of the fruit so they overlap.

If the apples have been sized, the pack to be used for the size of apples in the bin should be determined. This is done by placing some of them on their cheeks in the end of the box with the stem end of the apples all pointing away from or all toward the packer. If 2, but not quite 3, apples are needed to span the width of the box, it will be a 2–1 pack. If 3, but not quite 4, apples are needed to span the width of the box, it will be a 2–2 pack. If 4, but not quite 5, apples are needed to span the width of the box, it will be a 3–2 pack. If 5, but not quite 6, apples are needed to span the width of the box, it will be a 3–3 pack.

If the apples in the bin have not been sized, the packer should run as many boxes as are necessary to secure a uniform size in each box. After deciding upon the style of pack to be used for the box the packer is ready to begin packing the first layer. Wrap the apples so that the wrap is neat and tight. Place the apples in the box with the stems all pointing toward one end of the box in a correct alignment. Each apple in the last row should touch the end of the box. In packing succeeding layers be sure that the center of each apple is over the center of the pocket or depression formed by the apples in the lower layer. In case the packer has to do his own sizing, expertness has to be acquired in selecting apples of just the right size for the various counts, so that the pack will not come too high or too low. Guard against packs with ends too high, and consequent danger of slicing or partial crushing of the end apples.

METHOD OF WRAPPING

The wraps are in the paper holder, glazed side up. A rubber finger stall is worn on the forefinger of the left hand, as by its use single wraps are picked up easily (fig. 10, A). The wrap is picked up with the left hand, one corner pointing toward the packer, the center of the wrap in the center of the palm. At the same time an apple is picked up with the right hand (fig. 10, B).

The apple is thrown into the wrap with some force (fig. 10, C) in order to jerk up the edges of the wrap around the apple. The apple strikes on its cheek in the center of the wrap (fig. 10, D) with its stem end pointing midway between the thumb and index finger. As the apple is caught the thumb and fingers of the left hand are closed about the apple, forming a cup, and remain in this cupped position throughout the wrapping process. As the apple is thrown the right hand advances toward the blossom end of the fruit with fingers together and thumb extended at nearly right angles to fingers. The index finger is up and the little finger is down (fig. 10, E). The lower corners of the wrap are brushed closely over the apple with the thumb and forefinger of the right hand, bringing all corners of the wrap tightly together at the top, except the corner between the thumb and forefinger of the left hand (fig. 10 F).

Now, holding the apple tightly within the wrap with the thumb and forefinger of the right hand, both wrists are twisted toward the right. The apple turns within the cup formed by the left hand, the fingers of the left hand moving between the apple and the fingers

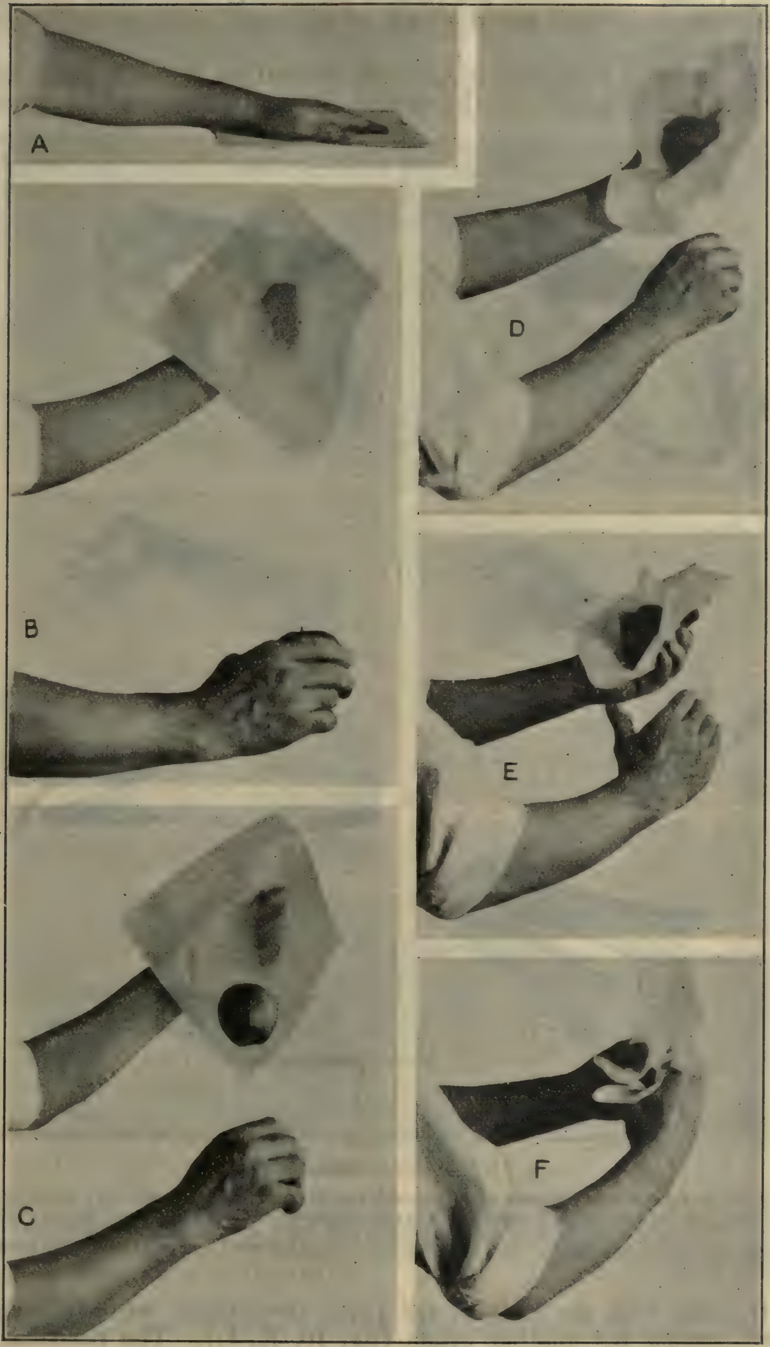

FIG. 10.—Method of wrapping an apple: (A) Picking up the wrap; (B) picking up the apple; (C) throwing the apple into the wrap; (D) position of apple upon striking wrap; (E) wrapping process, first stage; (F) wrapping process, second stage; (G) apple held

of the right. The hands are turned completely over, until the back of the left is upward and the back of the right is downward. (See fig. 10, G, H, I, J.)

The apple is now held in the cup formed by the left hand with its stem pointing between the second and third finger and is placed

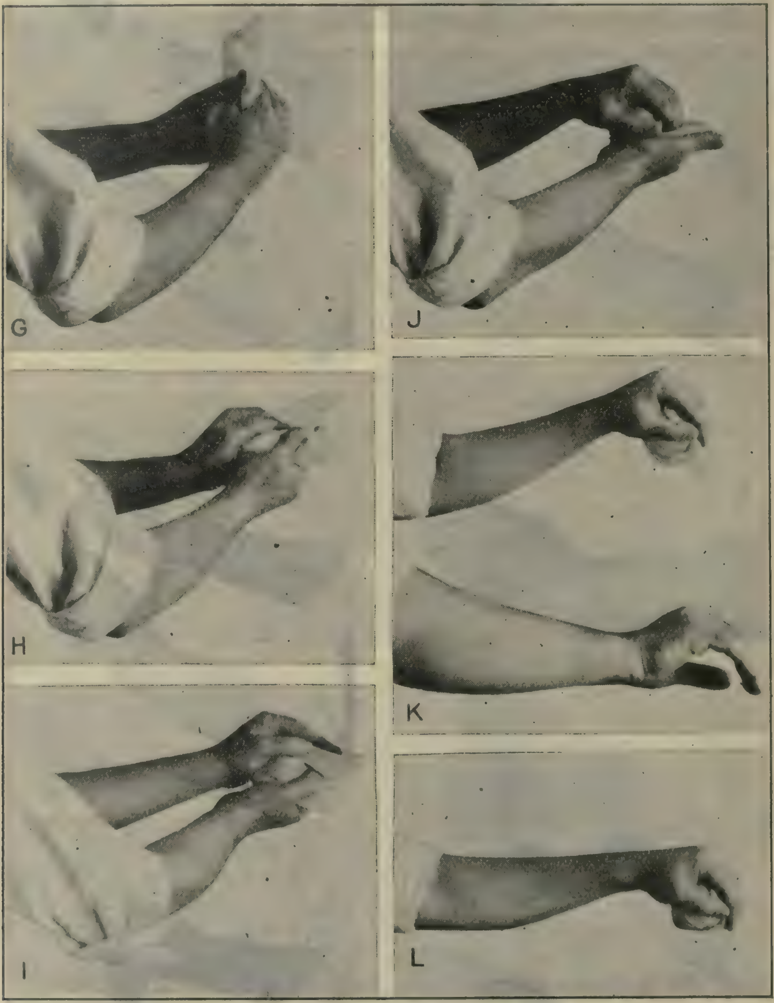

Fig. 10.—Continued

tightly in right hand, pressing apple against cup formed by left hand; (H) apple turned within cup formed by left hand, both wrists turning toward right; (I) hands turning over completely; (J) back of left hand upward, back of right hand downward; (K) apple ready for placing in box, right hand reaching for next apple; (L) placing wrapped apple in box

in the box with the tails of the paper downward, while the right hand reaches for another apple (fig. 10, K, L). The positions as shown in Figure 10 are described in detail, but it must be understood that, when wrapping, these positions blend into each other so rapidly that an expert packer appears to be picking up apples with his right hand and paper with his left, and placing the wrapped apple in the box. It is readily seen that if the wrap is picked up with the right hand and the apple with the left the motions would be reversed. Most apple packers use the general method described, although there are some variations in the details. Beginners should be warned against forming habits in the operations which result in lost motion, for such habits are difficult to overcome. Experienced packers will pack apples about as fast as they can pick them out of the bins. The average packer will pack from 100 to 125 boxes of machine-sized fruit in a day, but packers have been known to pack 325 boxes in 10 hours.

APPLE PACKS

Many styles and counts of packs have been used for boxing apples. Those described and illustrated are recommended, for by their use damage from stem punctures and bruises is decreased as compared with other styles and counts. These packs are here tabulated for the purpose of ready reference.

Apple packs

Style of pack (crosswise)	Number in rows (lengthwise)	Number of layers (depth)	Size or count	Style of pack (crosswise)	Number in rows (lengthwise)	Number of layers (depth)	Size or count
2-1	4-4	3	36	3-2	5-5	5	125
2-1	5-4	3	41	3-2	6-5	5	138
2-2	3-3	4	48	3-2	6-6	5	150
2-2	4-3	4	56	3-2	7-6	5	163
2-2	4-4	4	64	3-2	7-7	[c] 5	175
2-2	5-4	4	72	3-3	5-5	[d] 6	180
2-2	5-5	4	80	3-3	6-5	6	198
2-2	6-5	[a] 4	88	3-3	6-6	6	216
3-2	4-3	[b] 5	88	3-3	7-6	6	234
3-2	4-4	5	100	3-3	7-7	6	252
3-2	5-4	5	113				

[a] For flat apples. [b] For long apples. [c] Flat apples only. [d] All apples.

TWO-ONE PACK

Occasionally apples grow so large that they may be packed 2–1. (See fig. 11, *A*.) This pack is begun by placing an apple upon the bottom of the box in each corner and a third between the two, the third apple being of such size that it will not slip much more than halfway into the space between the first two apples. The bottom layer is filled out with apples in the same relative position as the first three. The second layer is begun by placing an apple in the space or pocket formed by the first three apples of the first layer. The apples in the second and third layers are placed over the spaces in the layers below. Three layers of the 2–1 pack fill the box. Rather than try to pack apples into the 2–1 pack, however, a more uniformly tight pack can usually be secured by mixing sizes a little and packing the apples 2–2.

TWO-TWO PACK

The 2–2 pack (fig. 11, *B*) is begun by placing an apple upon the bottom of the box in one corner and another midway between this apple and the other corner. The third apple is placed in the space between the first and second apples, and the fourth is placed in the space between the second apple and side of the box. All four apples will be of such size that the third and fourth will not slip more than halfway into the spaces left by the first two. The bottom layer is filled out with apples in the same relative position as the first four. The second layer is begun by placing two apples above the spaces in the first layer next the lower end of the box, continuing as in the first layer, the apples in the second and in each succeeding layer being placed over the spaces in the layer below. Four layers of the 2–2 pack fill the box.

THREE-TWO PACK

To start the 3–2 pack an apple is placed in each lower corner of the box and a third midway between the two (fig. 11, *C*). Two more apples are placed upon the bottom of the box in the two spaces formed by the first three. The five will be of such size that the last two will not slip more than halfway into the spaces left by the first three. The bottom layer is filled out with apples in the same relative position as the first five. The layer may be finished at the upper end of the box with either two or three apples. The second layer is begun by placing two apples above the spaces in the first layer next the lower end of the box, continuing as in the first layer, the apples in the second and each succeeding layers being placed over the spaces in the layer below. Five layers of the 3–2 pack fill the box.

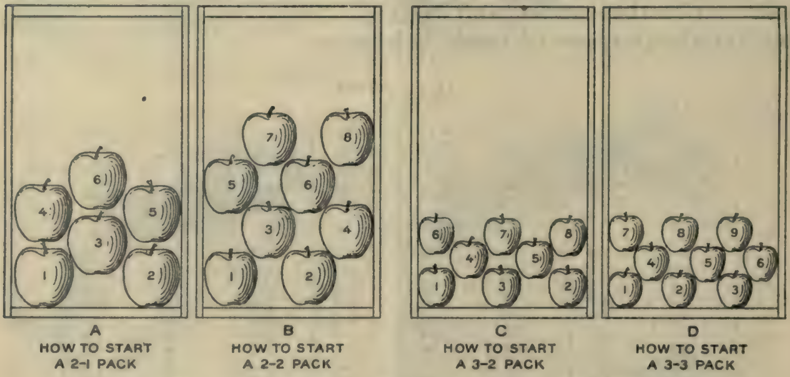

FIG. 11.—Diagram illustrating method of starting each style of pack

THREE-THREE PACK

The 3–3 pack (fig. 11, *D*) is begun by placing an apple in one lower corner of the box and dividing the remaining space across the box equally with two other apples, leaving a space in the corner of the box opposite from that in which the first apple is placed. Three other apples are placed upon the bottom of the box in the three spaces formed by the first three apples, the six being of such size that the second three will not slip more than halfway into the three spaces formed by the first three apples. The bottom layer is filled out with apples in the same relative position as the first six. The apples in each succeeding layer are placed over the spaces in the layer below. Six layers of the 3–3 pack fill the box.

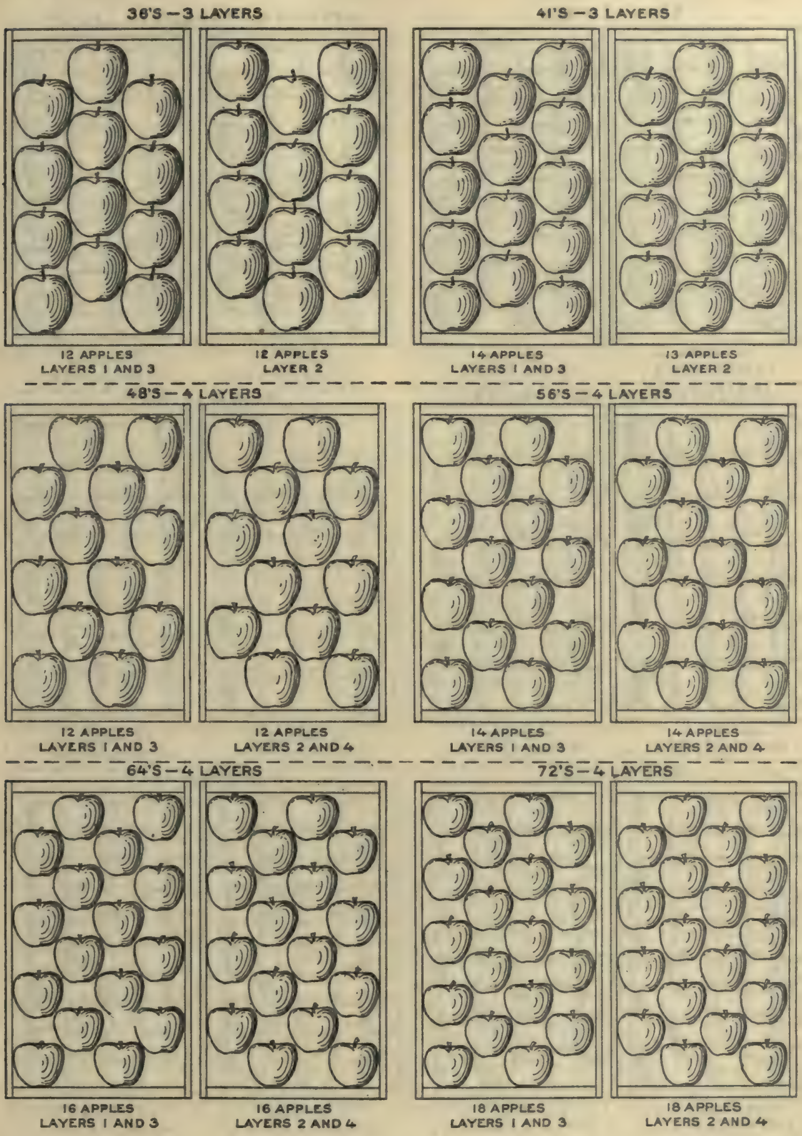

FIG. 12.—Diagram illustrating the arrangement and method of packing sizes 36 to 72 in layers in standard boxes. The number of apples in each box and the number of layers are given above each diagram. The number of fruits in each layer is shown below the diagram

DIAGRAM OF PACKS

Figures 12–15 give a diagrammatic illustration of the method of placing the apples of various sizes in the box. The arrangement as shown in the left-hand illustration of each size is that for the first or the bottom layer; the one on the right is the second layer, which is on top of the first. The third is the same as the first, and the fourth is the same as the second, and so on. Certain sizes are sometimes packed differently from the arrangement shown in the diagram, the packs here illustrated being the ones more commonly used and preferred at the present time.

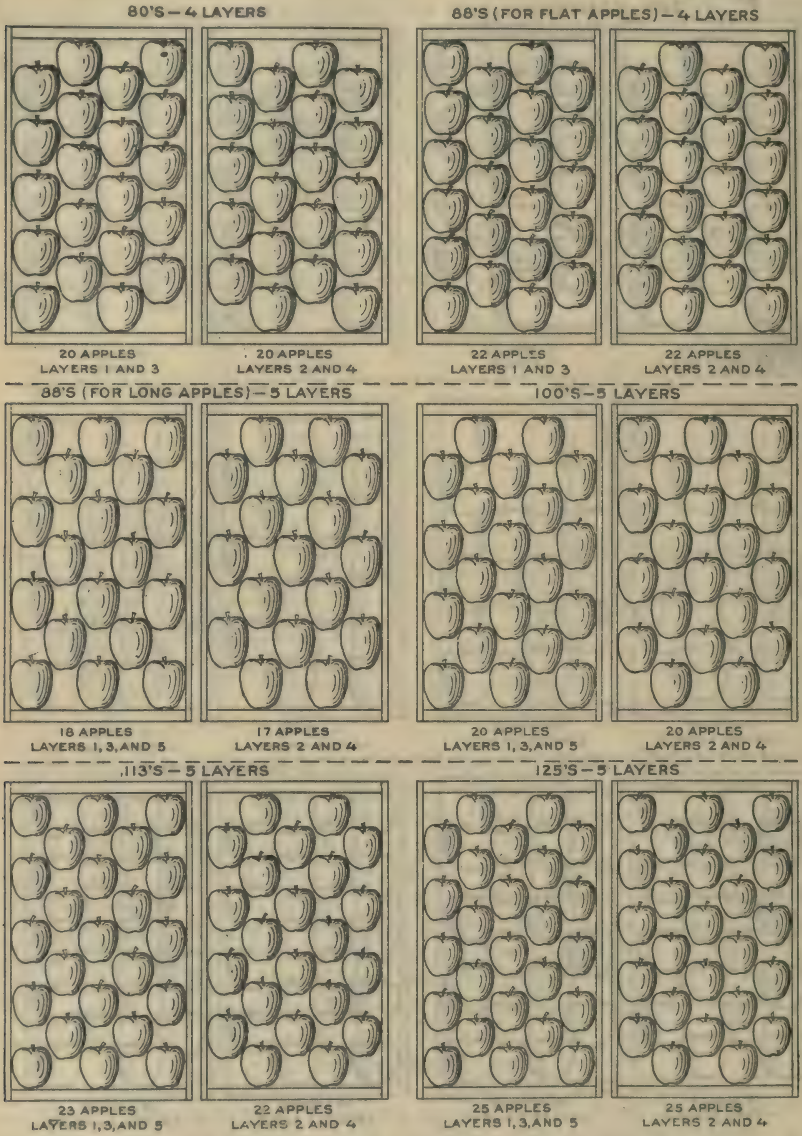

FIG. 13.—Diagram illustrating the arrangement and method of packing sizes 80 to 125 in layers in standard boxes. The number of apples in each box and the number of layers are given above each diagram. The number of fruits in each layer is shown below the diagram

DETERMINING THE COUNT

The number of apples in the box can usually be determined by counting the number of apples in the top layer and multiplying by the number of layers in the box. There are, however, certain exceptions in the 2–1 and 3–2 styles of pack.

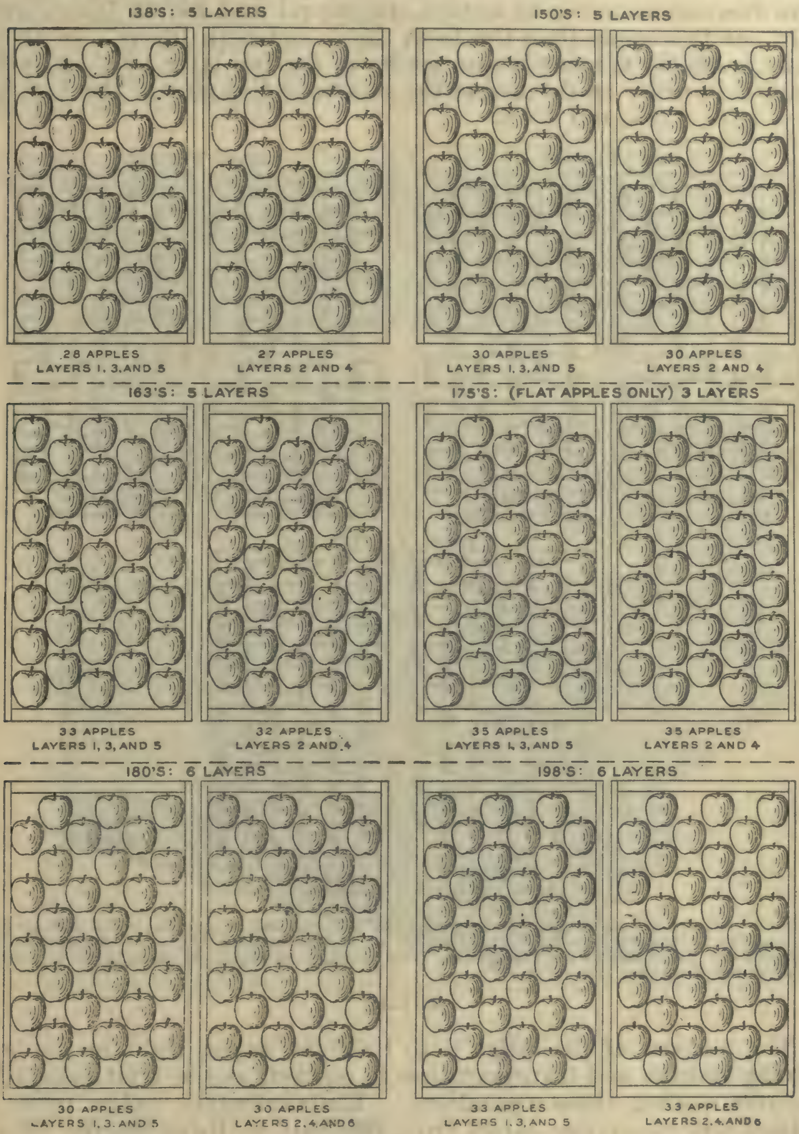
138'S: 5 LAYERS
28 APPLES LAYERS 1, 3, AND 5
27 APPLES LAYERS 2 AND 4
150'S: 5 LAYERS
30 APPLES LAYERS 1, 3, AND 5
30 APPLES LAYERS 2 AND 4
163'S: 5 LAYERS
33 APPLES LAYERS 1, 3, AND 5
32 APPLES LAYERS 2 AND 4
175'S: (FLAT APPLES ONLY) 3 LAYERS
35 APPLES LAYERS 1, 3, AND 5
35 APPLES LAYERS 2 AND 4
180'S: 6 LAYERS
30 APPLES LAYERS 1, 3, AND 5
30 APPLES LAYERS 2, 4, AND 6
198'S: 6 LAYERS
33 APPLES LAYERS 1, 3, AND 5
33 APPLES LAYERS 2, 4, AND 6

Fig. 14.—Diagram illustrating the arrangement and method of packing sizes 138 to 198 in layers in standard boxes. The number of apples in each box and the number of layers are given above each diagram. The number of fruits in each layer is shown below the diagram

When the rows lengthwise of the box in the 2–1 pack do not contain the same number of apples, the second layer will have one less apple than the top and bottom layers; therefore, to determine the count, multiply the number of apples in the top layer by 3 and subtract 1; 41's are an example.

When the rows lengthwise of the box in the 3–2 pack do not contain the same number of apples, the second and fourth layers contain one less apple than the first, third, and fifth layers. In these cases, multiply the number of apples in the top layer by 5 and subtract 2 in order to determine the number of apples in the box, as 88's, 113's, 138's, and 163's.

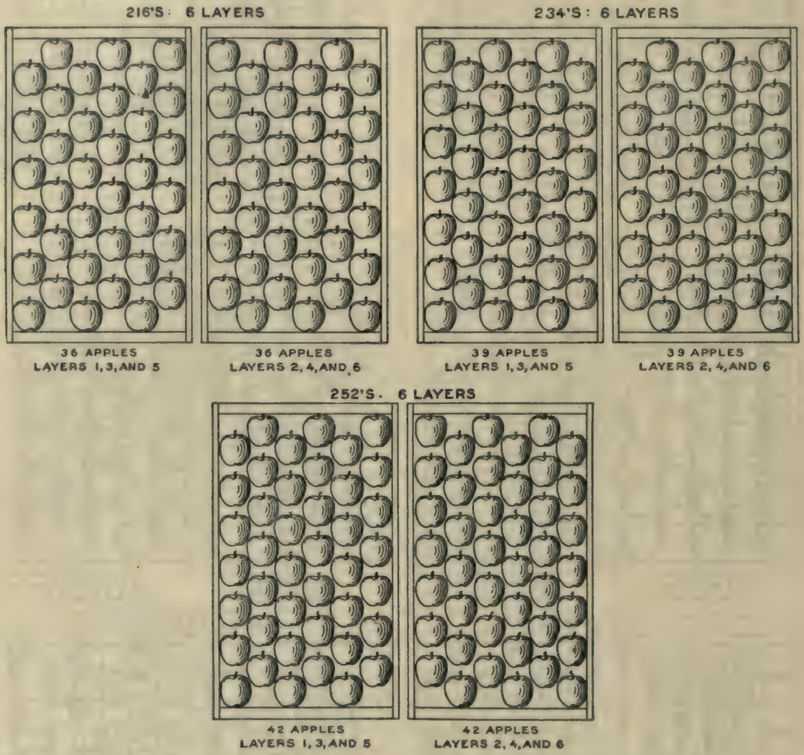

FIG. 15.—Diagram illustrating the arrangement and method of packing sizes 216 to 252 in layers in standard boxes. The number of apples in each box and the number of layers are given above each diagram. The number of fruits in each layer is shown below the diagram

BULGE

The purpose of the bulge is to hold the apples tight in the box during storage and transportation to market, as the fruit generally shrinks during these operations. The customary bulge upon a lidded box of apples varies from one-half to three-fourths of an inch, both top and bottom. The packing regulations enforced by some States require a minimum bulge of one-half inch. The packs should not be built too high, as undue bruising or slicing of the apples will occur in lidding. The bulge is secured by building the pack up in the middle, about 1½ inches above the side edges of the box, while the ends of the pack are brought lower (about one-fourth to three-eighths of an inch above the ends of the box.) (Fig. 16.)

One of the best methods of securing a bulge is to pack the first two and last two end rows of each layer with the apples having their shortest diameter, as measured from cheek to cheek, perpendicular to the bottom of the box.

Considerable difficulty is often encountered in obtaining the correct height of pack unless the packer regulates the tightness of the pack in accordance with the size of the apples for a given style of pack. In packing the larger sizes of any style of pack, crowding of the apples will result in a pack which is too high, but in packing the smaller sizes of any style of pack the pack will be too low unless it is very tight. This tightness is secured by drawing down the apples in the bottom layer two or three times as the layer progresses. For example, 88's and 100's are the largest of the 3–2 pack, and such apples should not be packed too tight; 163's and 175's are the smallest sizes of this style, and the bottom layer should be drawn toward the packer, resulting in a tighter pack through the entire box than with the largest sizes.

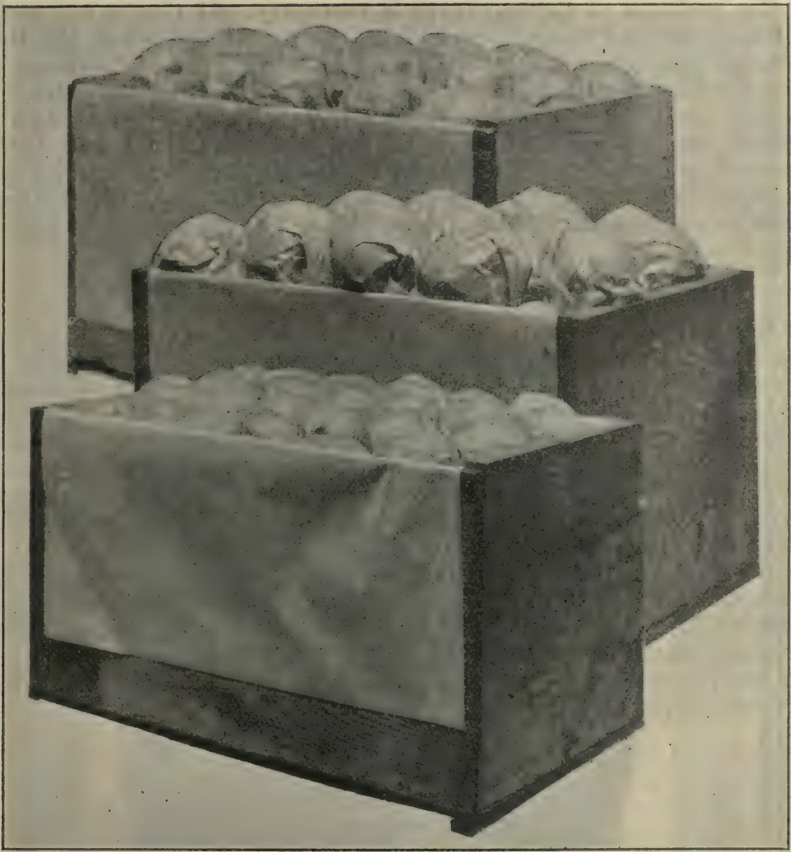

FIG. 16.—Upper box shows correct height and proper bulge; middle box is packed too high; bottom box is packed too low

A variation in the proper height of the apples in the unlidded box will also occur, depending upon the weight and size of wraps used and the strength of the packer. The strength used determines whether the folds of the paper are pressed down as the packer places the apples into the box, causing them to sink at once their eventual depths into their pockets.

EVENNESS OF TOP

An evenness of the top layer is necessary. If this is not accomplished some of the apples will be cut or bruised when the lid is pressed into position for nailing. Unless the pack is flat from side to side the lid will not only cut or bruise those apples which are higher than the others, but those apples which are lower than the others and do not touch the lid are likely to rattle and become bruised in handling. Although an expert packer can build a pack with an even top by using apples of an uneven size, still the surest way to secure a pack with a smooth top is to use apples of uniform size.

EXPERIENCE AND INSTRUCTION IMPORTANT

Before attempting to pack apples in boxes one should practice until he has developed the ability to wrap apples properly. At first he should not aim at speed but should remember that he must be able to wrap properly before he can expect to pack rapidly or well. The importance of building the first layer correctly can not be overemphasized, as it is the foundation for the other layers in the box. With most beginners expertness has to be acquired in placing this layer without having the apples twist sidewise. Obviously individual instruction by an experienced packer is helpful.

In some of the boxed-apple sections packing schools are held each fall under the auspices of the local commercial club, Young Men's Christian Association, or some similar organization. These schools, which are usually held for about two or three weeks prior to the harvesting season, are responsible for training many of the western apple packers.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1458

STRAWBERRY DISEASES

THE GREAT VARIETY of conditions under which the strawberry is grown necessitates different methods of culture and handling. Methods of control of strawberry diseases must be adapted to local conditions.

Severe attacks of leaf diseases—leaf-spot, scorch, and mildew—are best controlled by spraying or dusting. Often, however, frequent renewal of strawberry patches will serve to keep these diseases in check.

The diseases caused by nematodes may be avoided by planting strawberries in soil which is free from these pests. Infected land may be freed from nematodes by a three-year rotation with immune crops.

Fruit rots may be reduced by proper mulching. Careful handling and adequate refrigeration will greatly lessen the losses from rots which occur after picking.

Washington, D. C. Issued August, 1925

STRAWBERRY DISEASES

By Neil E. Stevens, *Pathologist, Office of Fruit-Disease Investigations, Bureau of Plant Industry*

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STRAWBERRIES are more widely grown in the United States than any other small fruit. Not only is the strawberry particularly adapted to the home garden and found to some extent in such gardens in every State, but centers of commercial production are located in many widely different regions throughout the country. From these large centers of production fresh fruit is distributed over a period of more than six months each year. The growth of this fruit in so many different regions under widely different conditions has resulted in the development of special cultural methods particularly adapted to local requirements, and the locations of the growing centers with reference to the markets served have given rise to somewhat different handling and shipping practices.[1]

The strawberry is not only the most widely grown of small fruits, but is also the most important. The crop of 1924, for example, was more than 266,000,000 quarts, grown on about 146,750 acres.[2] The farm value of this crop was over $35,000,000. (Fig. 1.)

The number of varieties of strawberries grown in this country is large. Although about 50 varieties (see Farmers' Bulletin 1043) may be considered of commercial importance, experimental testing plats often contain several hundred. New varieties are grown from seed with ease, and plants of several new varieties are offered to the trade each season.

---

[1] Darrow, G. M. Everbearing strawberries. U. S. Dept. Agr., Farmers' Bul. 901, 20 pp., illus. 1917.

More, C. T., and Truax, H. E. Preparation of strawberries for market. U. S. Dept. Agr., Farmers' Bul. 979, 27 pp., illus. 1918.

Darrow, G. M. Strawberry culture: South Atlantic and Gulf coast regions. U. S. Dept. Agr., Farmers' Bul. 1026, 40 pp., illus. 1919.

——— Strawberry culture: Western United States. U. S. Dept. Agr., Farmers' Bul. 1027, 29 pp., illus. 1919.

——— Strawberry culture: Eastern United States. U. S. Dept. Agr., Farmers' Bul. 1028, 51 pp., illus. 1919.

[2] Statistics of truck crops, 1921–1924. *In* U. S. Dept. Agr., Crops and Markets, v. 1, Mo. Sup., p. 415. 1924.

Darrow, G. M. Strawberry varieties in the United States. U. S. Dept. Agr., Farmers' Bul. 1043, 36 pp., illus. 1919.

In view of the extent of strawberry culture in this country, the different conditions under which the crop is grown, and the number of varieties cultivated it is obvious that strawberry diseases will vary in importance in different sections. Consequently, few general statements as to the severity of a given disease or the resistance to disease of strawberry varieties can be made with the expectation that they will be everywhere equally applicable. Methods of control must also be adapted to local conditions. What is undertaken in this bulletin is to describe the more important strawberry diseases and to give an account of such control methods as are of proved value.

LEAF DISEASES

The diseases here grouped under the general term "leaf diseases" will sometimes be found to affect other parts of the plant. Leaf-spot and scorch often occur on fruitstalks and mildew on the young fruit. They are most common and conspicuous, however, on the leaves.

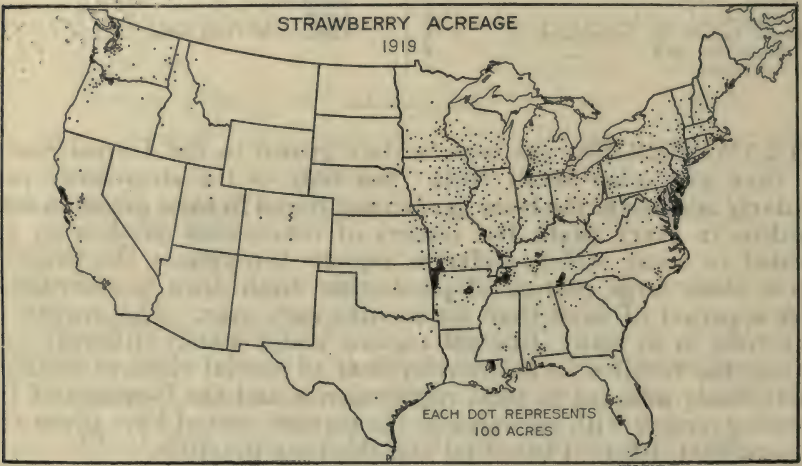

FIG. 1.—Outline map of the United States, showing the acreage of strawberries in 1919 according to the census of 1920, each dot representing 100 acres. (From A Graphic Summary of American Agriculture, Yearbook of the Department of Agriculture, 1921)

LEAF-SPOT[3]

One of the most widely distributed and best-known diseases of strawberries, leaf-spot, as its name indicates, is usually confined to the leaves. When the spots caused by the disease first appear they are of a reddish or purplish tint, but as they increase in size the center of each spot becomes paler and finally gray or almost white. A typical fully developed spot is about an eighth of an inch in diameter and has a dead white center surrounded by a distinct reddish or purplish border, which finally merges into the color of the healthy leaf (fig. 2). The spots are scattered irregularly over the surface of the leaf and often become so numerous as to cause the death of a large portion of the leaf and in extreme cases even of the plant. Usually, however, the injury due to this disease is chiefly that of weakening the plant and reducing the crop through the loss of needed leaf surface.

---

[3] Caused by *Mycosphaerella fragariae* (Tul.) Lindau.

SCORCH[4]

Scorch is almost as common on strawberries in this country as leaf-spot, for which disease it may be mistaken in the early stages, when the spots or blotches, usually purplish in color, are irregular in outline and vary in diameter from one-twentieth to one-fifth of an inch (fig. 3).

The diseased areas gradually enlarge, and many of them grow together. In severe cases the whole leaf may become purplish or reddish in color. Soon, however, the leaf margins become dry (fig. 4) and have the burned or scorched appearance which has given rise to the name of the disease.

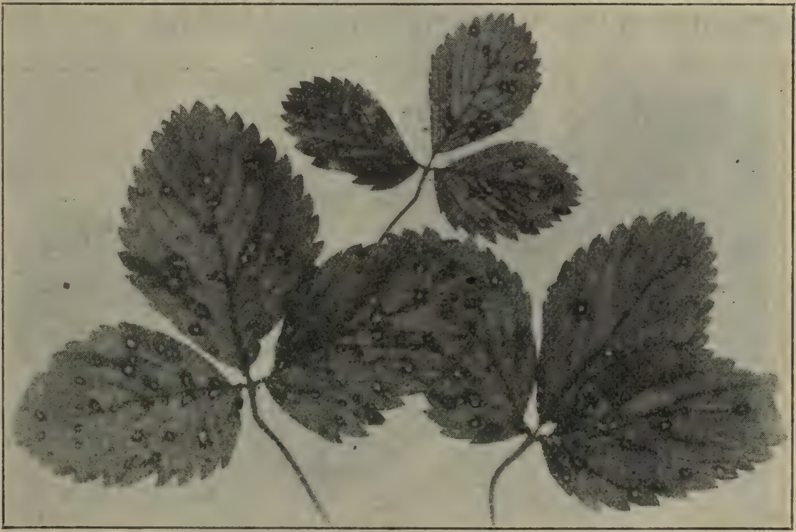

FIG. 2.—Strawberry leaf-spot. (Photographed by Stoddard)

In case of severe infection entire plants may be killed or so weakened as to be worthless. One type of injury caused by this disease that results in large losses is the infection which often occurs on the fruit stalks, sometimes girdling them and thus causing the death of the flowers and young fruit.

CONTROL OF LEAF-SPOT AND SCORCH

That leaf-spot can be controlled by spraying with Bordeaux mixture has been known for at least 30 years. Recent experiments by the Connecticut and North Carolina Agricultural Experiment Stations have demonstrated that scorch may also be controlled by this method.

---

[4] Caused by *Mollisia earliana* (E. and E.) Sacc. (*Diplocarpon earliana* (E. and E.) Wolf).

It has been found most satisfactory for the control of leaf-spot and scorch to spray with 4-4-50 Bordeaux mixture as soon as growth is well started in the spring—that is, when the first leaves are about half grown—and to repeat the treatment as often as may be necessary to keep the foliage well covered until the first berries are about one-third grown. It may be necessary to spray as often as every 10 days. Usually one or two additional applications in the late summer will result in much better control.

Whether spraying should be undertaken in any particular case must be decided by the individual grower, taking into consideration its cost and the probable extent of the loss from these diseases. Often it proves more economical merely to reduce the diseases so far as is practicable by frequent renewal of strawberry patches and by reducing the chances for infection. Mowing off and burning old leaves and removing diseased leaves before plants are set tend to reduce infection from strawberry scorch and leaf-spot.

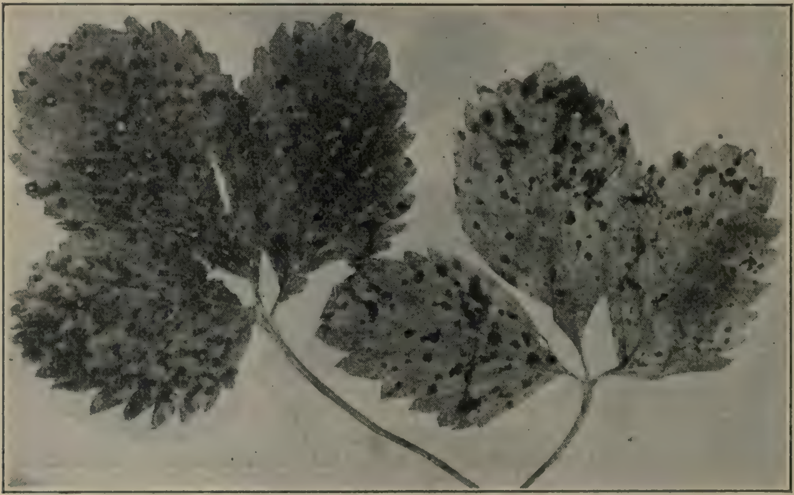

FIG. 3.—The "spot" stage of strawberry scorch. (Photographed by Wolf)

It is wise also to avoid setting any varieties which appear particularly susceptible to these diseases in a given locality. Lists of strawberry varieties which have proved very susceptible or resistant to certain diseases have been published at various times. These come from different workers and are frequently contradictory, the fact being, of course, that a variety may be obviously susceptible in one place or in one season and almost free from disease in another place or during another year. Reliable information as to the relative susceptibility of different varieties to various diseases is very difficult to obtain, owing to the fact that in large strawberry-growing sections one or two varieties are likely to be grown to the exclusion of others, and experimental plats usually contain only a relatively few plants of any given variety and are often maintained for only a few years. In order to secure reliable information on this point it would be necessary to carry on extensive comparative tests of the leading varieties in various sections of the country for a period of at least five or six years. The wisest policy for the present will be for each grower to select varieties on the basis of local experience in the region.

LEAF BLIGHT[5]

Another disease which causes injury to strawberry leaves and leafstalks and has been found to be serious in Illinois and Michigan is angular spot, sometimes called blight. The dead areas caused by this disease even in the early stages are much larger than those made by leaf-spot. Usually there is only one injured region to a leaflet, although there may be three or four. In an advanced stage this disease is distinguished by the more or less triangular shape of the dead area, which often extends from one of the larger veins to the side of the leaflet and includes all the leaf tissue between the edge of the leaflet and the vein.

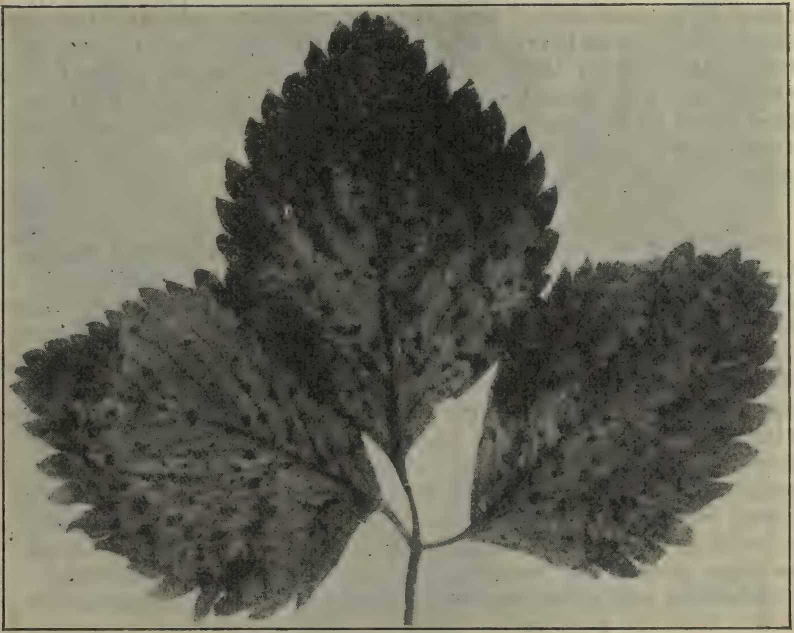

FIG. 4.—An advanced stage of strawberry scorch. The leaves have begun to dry along the margins

MILDEW[6]

Mildew has long been recognized as a serious disease in England and is locally destructive in this country. The most conspicuous symptom of the disease is the curling of the leaves. The edges of the leaflets gradually turn upward until much of the under side is exposed. If the under side of a diseased leaf is closely examined it will be found to be covered with a whitish down composed of the causal fungus.

---

[5] Caused by *Dendrophoma obscurans* (E. and E.) H. W. And.
[6] Caused by *Sphaerotheca humuli* (DC.) Burr.

For the commercial control of strawberry mildew in this country the ordinary sanitary measures recommended for leaf-spot and scorch have usually proved sufficient. Recently, however, the New York (Geneva) Agricultural Experiment Station has demonstrated in the Hudson Valley that mildew may be practically eliminated even during seasons of severe infection by four applications of 85–15 lime-copper dust. The first application was made as the first buds were expanding in the cluster and the succeeding ones at intervals of about 12 days.

DISEASES CAUSED BY NEMATODES

Two distinct diseases of strawberries, root-knot and gall, are caused by nematodes. These are wormlike animals, and the species which affect strawberries are very small—from one-fiftieth to one twenty-fifth of an inch in length. The nematode gall of strawberries has been found only in the Northwest. Root-knot, on the other hand, is found to some extent in all except the more northern States, but is usually serious on strawberries only in the Southern States.

NEMATODE GALL [7]

The disease of strawberries known as gall was first found in the United States about 10 years ago in Oregon and is still known only in the northwestern part of the country. The disease appears to affect only those portions of the plant which are above ground. The plants, as a whole, are usually somewhat dwarfed and their color is of a lighter green than that of normal plants. As shown in Figure 5, affected leaves become wrinkled, swollen, and often much reduced in size. On the leaf and fruit stems are often formed conspicuous galls which contain the nematodes in great numbers. The nematode which causes gall on strawberries [8] is known to occur in the United States on hyacinth, red clover, alfalfa, false dandelion, and the wild strawberry (*Fragaria chiloensis*) of the Pacific coast. It has been proved by inoculation experiments that nematodes from strawberries will affect red-clover seedlings. This suggests the possibility that the pest passes from one host to another in nature and that it may be dangerous to plant strawberries in fields in which affected crops of red clover or alfalfa have been grown. For the present, however, the most necessary control measure is the obvious one of not planting strawberries which are infected or those which come from infected fields.

ROOT-KNOT [9]

As indicated by its name, the disease known as root-knot is characterized by swellings or enlargements of the roots. Usually root-knot produces no malformations on those parts of the plant which are above ground, and as a result it is frequently overlooked. If the roots of an infected plant are examined, however, the disease is usually readily detected. In severe cases great numbers of the finer roots and many of the large roots are found to be much enlarged at various points. These swellings, which are caused by the nematodes within the roots, vary greatly in size and shape.

---

[7] Caused by the nematode *Tylenchus dipsaci* (Kühn) Bastian.

[8] Godfrey, G. H., and M. B. McKay. The stem nematode *Tylenchus dipsaci* on wild hosts in the Northwest. U. S. Dept. Agr. Bul. 1229, 9 pp., illus. 1924.

[9] Caused by the nematode *Heterodera radicicola* (Greef) Muell.

The extent of injury to strawberries due to root-knot is very difficult to estimate. Relatively few strawberry fields in the older growing regions of the South are free from root-knot, and the reduced yield due to the disease has come to be taken as a matter of course. Often, however, the disease becomes serious enough to cause the death of part of the plants and can no longer escape notice.

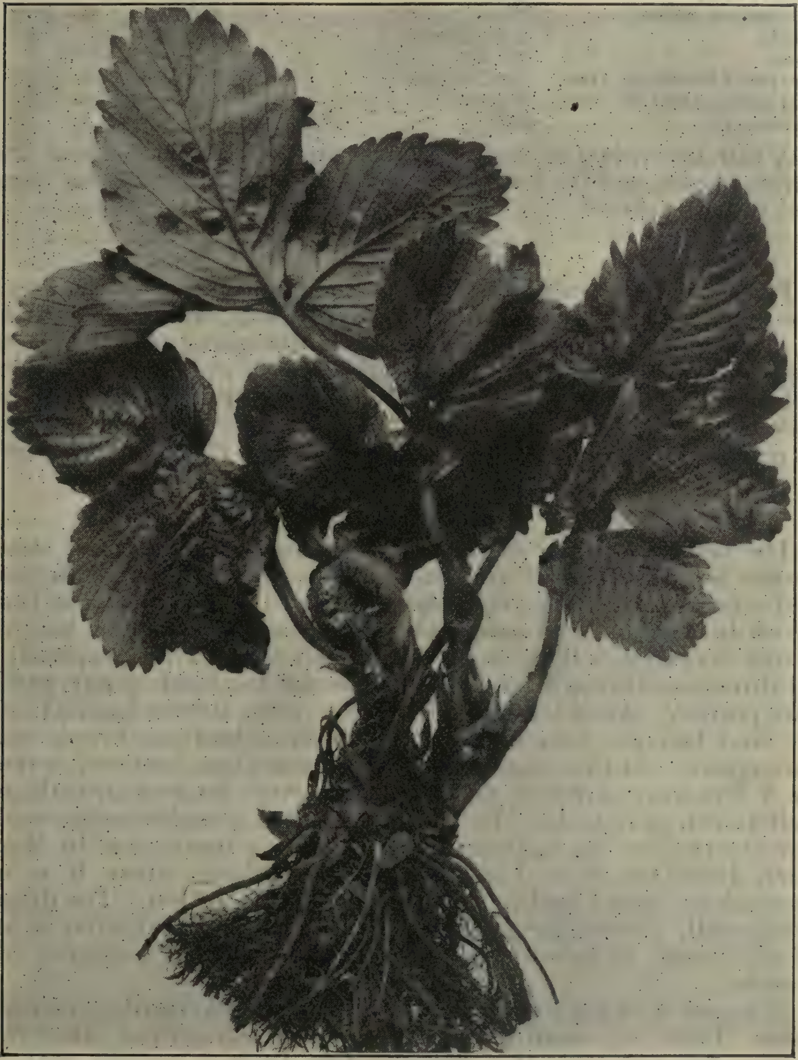

FIG. 5.—Nematode gall of strawberry. (Photographed by Byars)

Control.—When available, new land or land known to be free from the root-knot nematode should be used for strawberries. Infected fields, however, may be largely freed of infection by a three-year rotation with crops which are immune to this nematode.

The following plants are known to be immune or only slightly susceptible to root-knot.

- Barley.
- Beggarweed.
- Broomcorn millet.
- Chufa.
- Corn.
- Cowpea (Brabham, Iron, Monetta, and Victor varieties).
- Grasses (nearly all).
- Kafir.
- Milo.
- Natal grass.
- Peanut.
- Pearl millet.
- Redtop.
- Rye.
- Sorghum.
- Soybean (Laredo variety).
- Timothy.
- Velvetbean.
- Wheat.
- Winter oats.

A full description of the root-knot nematode, its characteristics on various hosts, and the known methods of control are given in Farmers' Bulletin 1345.[10]

FRUIT ROTS

Fruit rots of strawberries, both on the plant and after the berries are picked, are caused by a variety of diseases, some of which are now known only in certain localities. In discussing each disease the region in which it is known to be serious will be indicated. This does not mean, of course, that the disease does not occur in other places; indeed, it is highly probable that many of these rots will be found in regions widely separated from those in which they are now known.

GRAY-MOLD [11]

The best-known and most widely distributed fruit rot of strawberries is that caused by gray-mold. This disease affects both green and ripe berries. The rot usually starts in the part of the berry which is next to the ground or touches another berry or a leaf. It is first noticed as a light-brown rather soft spot. The rot spreads in all directions through the berry and is not localized in any particular portion. After the berry is wholly rotten it soon begins to dry out and becomes firm and tough and of a uniform brown color throughout. At this stage the berry becomes almost entirely covered by a fine gray powdery or dusty appearing fungous growth, the well-known gray-mold. This disease is most common in the cooler strawberry-growing regions. It is often very destructive in Maryland, Delaware, New York, and New England, where it is not unusual for 10 per cent or more of the crop to be lost. The disease is especially favored by moisture and may become destructive in any of the large strawberry-growing sections during continued wet weather.

The growth of gray-mold can not be entirely prevented by refrigeration. Under the conditions found in many refrigerator cars strawberries affected with this disease often become covered with an abundant growth of soft, fluffy gray mold, which is very conspicuous and seriously hurts the sale of the entire load. Consequently it is important that berries affected with gray-mold be carefully culled out during picking and packing.

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[10] Godfrey, G. H. Root-knot: Its cause and control. U. S. Dept. Agr., Farmers' Bul. 1345, 27 pp., illus. 1923.

[11] Caused by *Botrytis* sp.

The injury caused by gray-mold is not confined to the fruit. The blossoms are frequently blighted by this disease, and under favorable conditions leaf and flower stalks may be infected and the whole plant thus seriously injured.

TAN-ROT [12]

The so-called tan-rot is important, especially during rainy seasons, in Louisiana, Florida, Arkansas, Virginia, Maryland, and North Carolina. It may attack either green or ripe berries, forming slightly sunken tan-colored areas, which usually develop on the side of the berry. The rot extends into the pulp, so that the rotten portion forms a cone with its base at the surface of the berry. The outer layer of this diseased area becomes soft, and as the core of the rotten portion is held together by the rot fungus it is easily removed intact with the point of a knife or pencil. This characteristic serves to identify this trouble readily.

LEATHER-ROT [13]

Leather-rot, which has been found in Louisiana, Mississippi, Arkansas, Missouri, Tennessee, Kentucky, and Illinois, is readily distinguished from other fruit rots by the bitter taste of berries even slightly rotted. This disease may affect either ripe berries or green ones in any stage of development. When green berries are affected, all parts become dark brown over the affected areas or brown at the edges, shading off into the natural green. Partly colored berries show the same light-brown color at the center, but the spot shades off into purple and finally to the red of the berries. If a berry affected with this disease is cut across, a marked browning of the vascular strands is readily noted. This is usually accompanied by a less marked browning of the other tissues. At no time is there any clear line separating the diseased and the healthy flesh, nor can the diseased portion be easily removed, as in the case of tan-rot. The disease is most noticeable after rainy periods, especially if the weather is warm. Leather-rot has proved very serious during recent years in White County, Ark., and in Tennessee. During some years more than one-fourth of the crop has been lost.

HARD-ROT [14]

Hard-rot is known to be serious in the strawberry fields of central Florida, and it has been found in North Carolina, Arkansas, and Tennessee. As the rot is caused by a soil fungus it almost always occurs on the side of the berry which comes in contact with the soil, and a small quantity of soil will usually be found clinging to the decayed spot.

The affected berries are generally one-sided and show a hard brown rot, separated from the sound portion of the berry by a distinct line. The portion of the berry not actually penetrated by the rot fungus remains unchanged both in appearance and in taste.

---

[12] Caused by *Pezizella lythri* (Desm.) Shear and Dodge.
[13] Caused by *Phytophthora cactorum* Leb. and Cohn.
[14] Caused by *Rhizoctonia* sp.

LEAK [15]

The most common and destructive rot of strawberries in transit and on the market is that almost universally known as leak. As its name indicates, this rot is characterized by the collapse of the berry and the loss of much juice. It is not uncommon for the juice to drip from boxes and crates of badly infected fruit. The black-mold destroys strawberries more rapidly than any other fungus now known, and it is almost always present in packing sheds and on the markets. Fortunately this mold usually gains entrance to the berry through wounds and grows very slowly at temperatures below 50° F. The rate of growth increases very rapidly, however, with the rise of temperature above this point. Occasionally, especially under conditions of extreme moisture, leak appears as a field rot.

CONTROL OF FRUIT ROTS

The field rots of strawberry fruits, particularly gray-mold and leather-rot, are most abundant during wet weather. Well-drained patches in which rain water does not stand between the rows after each shower usually suffer less from fruit rots. In the same way patches which are largely free from weeds and therefore dry out more quickly after rains are usually less subject to these diseases. A useful sanitary measure and one followed by many progressive growers is to pay pickers for boxes of culls at the same rate as for good berries. This practice not only serves to get rid of the rotten berries which scatter infection to sound fruit but removes the temptation for pickers to put decayed berries in the boxes with good ones.

Mulching tends to reduce fruit rots. Spraying has been tried with some indication of success but can not as yet be confidently recommended.

All rot fungi are favored by high temperatures. Although gray-mold can not be entirely checked by any degree of refrigeration which will not injure the fruit itself, even this rot grows much more slowly at low temperatures. It is therefore of first importance that berries which are to be kept for some time or shipped long distances should be cooled as quickly as possible and kept cool until they reach their destination. A useful aid in accomplishing this and one that has proved most advantageous in practice is to pick as large a part of the crop as possible early in the day while it is still cool. Most rot fungi, particularly black-mold, usually gain entrance to the berry through injuries. Careful handling in picking, packing, and loading is absolutely necessary if severe loss from rot is to be prevented. When practicable, as when most of the picking is done by the grower's family or by experienced help, the berries may be sorted as picked. This eliminates rehandling in packing and is probably the most desirable procedure.

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[15] Caused by the common black-mold, *Rhizopus nigricans* Ehrb.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1459

SELLING BLACK-WALNUT TIMBER

BLACK WALNUT is a two to three million-dollar timber crop that comes not from extensive forests but from scattered single trees or small groups of trees on farms in 33 States. To make money for its producers it must be cut and marketed intelligently. The farmer must have some knowledge of logging, timber appraising, log scaling, and marketing if he is to realize a profitable return on this valuable by-product of his farm. The purpose of this bulletin is to give him in brief and without technicalities the information he needs.

Washington, D. C. Issued August, 1925

SELLING BLACK WALNUT TIMBER

By Warren D. Brush, *Scientific Assistant, Forest Service*

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BLACK WALNUT AS A FARM CROP

BLACK WALNUT (*Juglans nigra* L.) grows best on agricultural lands, and manufacturers of walnut lumber and veneers depend on the farmers for their supplies of logs.

In Ohio, Indiana, Illinois, Kentucky, Tennessee, Missouri, Iowa, and 26 other States (fig. 1) walnut grows naturally on farm land and in most cases can yield the farmer a good return if properly marketed. Farmers in these States are now selling $2,500,000 worth of walnut logs every year—a substantial item in the sum total of diversified farming.

Manufacturers want black walnut because of qualities no other wood has in the same combination. It works well with tools. It holds its shape in seasoning. It shrinks, swells, and warps very little in the finished product. It takes a good finish, and when finished has a very attractive appearance.

Black-walnut trees bring higher prices than any other kind of timber grown on the farm, and these prices have been increasing since 1915. Walnut is primarily a good wood for cabinetwork and furniture making of all kinds. Other cabinet woods, as well as walnut, are growing scarce. This has the effect of increasing the price of walnut, and its value will in all probability continue to rise.

PRACTICAL SUGGESTIONS ON SELLING

In order to dispose of his timber to good advantage the walnut owner needs to know something of how to appraise and scale his logs, and how to cut and market them. As far as regards the actual selling of his timber, the things he must know are: (1) The sizes and grades of walnut logs for which the buyer will pay highest prices; (2) how his crop grades and how much it amounts to; (3) how to reach the best market; (4) how to sell to the best advantage; (5) what prices his timber should bring.

MARKET SPECIFICATIONS FOR LOGS

Black-walnut logs may be classed into four grades. These are, in order of importance, No. 1 veneer (or " Veneer ") No. 1 lumber (or " Good," or " Good Mill "), No. 2 lumber (or " Common "), No. 3 lumber (or " Cull "). Not all of these grades are employed by every manufacturer; some firms do not have a veneer log grade, and include logs suitable for veneer in the grade " No. 1 lumber." Walnut stumps are not separated into grades because the value of each stump must be judged separately.

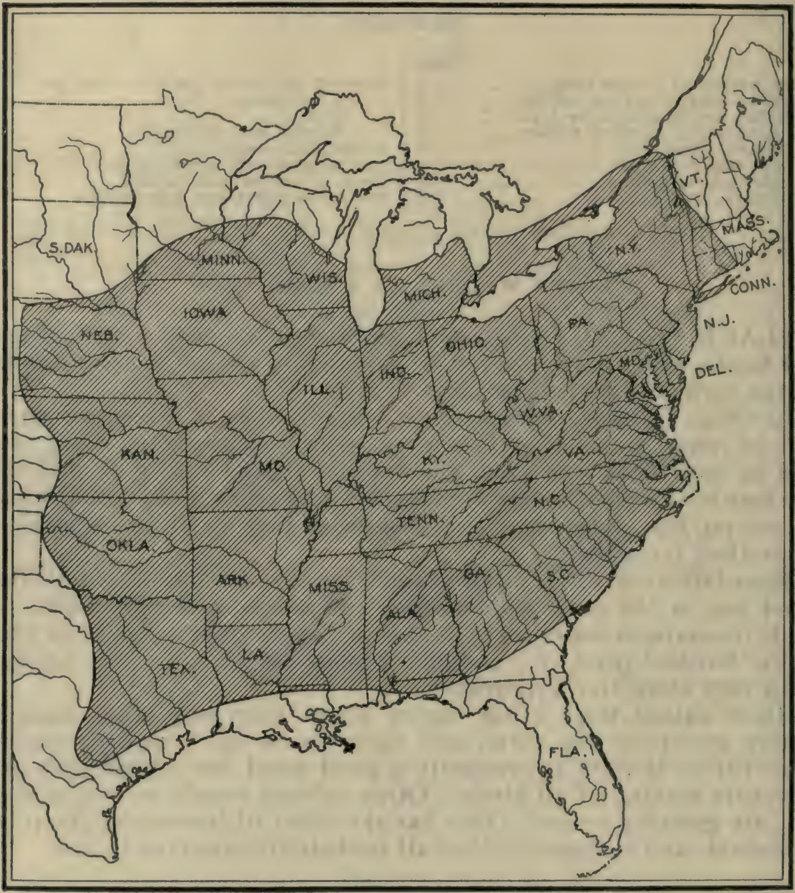

Fig. 1.—Botanical range of black walnut

Veneer logs are the very best in freedom from blemishes of any kind and are required to be practically free of all visible defects,[1] such as knots, rot, and splits,[2] and must be smooth and straight.

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[1] Any irregularity in the wood that lowers its quality.

[2] These defects, particularly splits and rot, often can not be detected in the standing timber. A split is merely a lengthwise separation of the wood.

At most a small sound knot near the end of the log may be allowed. Frequently a limitation is placed on the amount of sapwood or the lighter outer wood, as distinguished from the darker heartwood, that the veneer log shows. This limitation is applied to the smaller logs in which the heartwood is not greatly developed. Three or even two inches of sapwood is often enough to disqualify the smaller logs for this grade. The smallest diameter (measured at the small end) of logs that are admitted in this grade varies from 16 to 20 inches with different firms. Some firms will accept logs in the veneer grade somewhat smaller than their specifications call for if they are of unusually good quality, clear, straight, round in cross-section, and with a very thin rim of sapwood. The shortest length of log allowed in this grade is 6 feet.

No. 1 lumber, Good or Good Mill, calls for logs clear of defects or practically clear and straight or reasonably straight. Some firms have very definite specifications describing the kind and number of defects allowable, such as knots, rot, splits, shakes, and checks.[3] These defects are sometimes limited to within 1 foot of the end of the log, or in larger sizes of logs one such defect may be allowed regardless of location. Holes and two or more hearts[4] are also classed as defects.

The diameter is usually specified at not less than 12 inches at the small end inside the bark. Some purchasers take none less than 14 inches or possibly accept only a few in this grade at 12 and 13 inches in diameter.

Lengths are commonly 8 to 16 feet in 1-foot intervals (that is, 8, 9, 10, etc.). In some cases there is a limitation on the proportion of lengths under 10 feet. Some firms allow a few 6 and 7 foot lengths, particularly if the logs are large and of good quality. In general, buyers require the smaller sizes and shorter lengths to be practically clear, and allow more defects in the larger and longer logs.

No. 2 and particularly No. 3 lumber log grades are often not specified. These grades cover short lengths, smaller diameters, and more defective material than the other grades.

The No. 2, or Common, grade generally includes a large number of the smaller logs, which are too defective to go into the No. 1 grade, such as those containing a considerable number of knots, bad checks, and splits, and some rot. Logs in this grade must, however, contain a large proportion of good quality wood. Logs as small as 10 inches in diameter, if clear of defects, may be included in this grade, but 12 inches is the usual smallest diameter. The usual length specified is 6 feet and over.

No. 3, or Cull, logs are very defective, but must be capable of producing some good lumber. Small clear logs 10 and 11 inches in diameter may be included in this grade, and logs in which metal, such as fencing and nails, has been imbedded. The specified length is 6 feet and over. Many firms will not buy either of these grades because the cost of transportation is too great to make their purchase profitable.

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[3] A shake is a separation of the wood occurring principally along or between the growth rings; that is, in a circular direction as seen on the end of the log. A check is a separation of the wood extending across the growth rings. These can not usually be seen in the standing timber.

[4] The center of the growth rings as seen on the end of the log is termed the "heart."

Following are examples of actual specifications for the four different log grades and give a fair idea of what may be required:

Veneer.—Logs 18 inches and up in diameter, at least 8 feet long; free of all visible defects except occasionally a sound knot near the end; straight and not too sappy.

No. 1 lumber.—Logs 12 inches and up in diameter, sound ended, straight, with not more than two sound knots; 8 to 16 feet long, with not more than 25 per cent of 8 and 9 foot lengths.

No. 2 lumber.—Logs 12 inches and up in diameter exclusive of badly crooked and shaky logs, of logs with bark sores,[5] and logs containing more than four knots; 6 to 16 feet long, with not more than 30 per cent less than 10 feet.

No. 3 lumber.—All logs below the grade of No. 2, but which in the inspector's opinion will produce some good lumber. This grade includes all clear logs 11 inches in diameter, also all logs containing windshake or evidence of having iron or other metal imbedded in them.

Some firms make a deduction in measurement for holes and decay instead of placing the logs in a lower grade. The general character of the log must be very good, however, to allow its admission in the better grade with such a deduction.

Black-walnut stumps are used in the manufacture of veneer. To be valuable a stump must have a wavy or irregular grain, called "figure," which is most often present in the wood at the curved portion at the base of the tree where the roots extend out from the trunk. This figure, if discernible in the standing tree, is generally indicated by irregular bark ridges or by a ridged surface under the bark.

Since this figured condition is not easily determined by one who is unfamiliar with it, the decision as to whether a stump is figured must generally be left to the buyer. Figured stumps are required to have a minimum diameter of 21 or 22 inches at the upper end and a length of at least 3 feet. They should be practically free from defects such as cracks, crevices, and rot. To bring the best prices stumps should be figured for at least two-thirds of their length. Those with less figure are sometimes classed as No. 2 stumps and bring a lower price.

Stumps are usually sold in the same way as logs, by the board foot, log scale, according to length and diameter inside bark at the small end.

ESTIMATING STANDING TIMBER

There are several reasons why the owner of black-walnut timber should determine as nearly as he can the amount of timber he has for sale.

(1) He will know whether he has a sufficient quantity to warrant shipment of the logs.

(2) He can get some idea of how much his timber should bring him.

(3) He can tell prospective buyers about how much he has that is salable.

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[5] An irregular growth of the bark, indicating a knot or other defective growth of the wood underneath.

(4) If the timber is sold standing, it will serve as a check against the buyer's estimate and may help the owner to get a fair price for it.

If the owner has not had previous experience in measuring and estimating timber, his results may be far from accurate. This is particularly true in regard to determining the value, for the price depends so largely on the nature of the defects present. Even a rough estimate, however, will be of value and will enable him to deal with the buyer to better advantage.

In estimating timber it is necessary to determine the number of logs and the size of each that can be cut from the standing tree.

Timber is commonly purchased on the board-foot basis, the number of board feet in any log depending on its length and its diameter at the small end inside the bark.

Table 1 gives the number of board feet in logs of different sizes according to the Doyle log rule, which is the log rule commonly used in measuring black-walnut timber. A log 15 inches in diameter inside the bark at the small end and 12 feet long, according to the table, contains 91 board feet; one 21 inches in diameter at the small end and 13 feet long contains 235 board feet.[6] It will be seen that the number of board feet in a log increases greatly with the increase in diameter size. Since the value for each thousand board feet in a log also increases greatly with increased diameter, it follows that it is advantageous to the seller to convert his trees into logs which have the largest possible diameters at the small end and at the same time conform to the specifications of the buyer. It is also important, of course, that the logs be of as high quality as possible. If a log is to be classed high in quality, serious defects, such as knots, should be located near the end of the log. Where it can be done, therefore, it is advantageous to cut the tree into lengths at the location of such a defect. This matter of cutting the trees into log lengths is discussed more fully later in this bulletin.

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[6] The formula used in this rule is as follows: To determine the contents of a log deduct 4 from the diameter (in inches) of the small end, divide by 4, square the quotient, and multiply by the length of the log in feet. This log rule gives less than the actual amount of lumber that can be sawed from the smaller logs. For instance, a log 12 inches in diameter at the small end and 16 feet long scales 64 board feet by the Doyle rule, whereas approximately 100 board feet of lumber can be sawed from it. Similarly, a log 16 inches in diameter, 16 feet long, scales 144 board feet, and it will yield about 180 board feet of lumber. The Doyle rule, therefore, is disadvantageous to the seller when the logs run small in size, as they generally do in black walnut. It is, however, the common log rule for walnut and in some States the legal rule for measuring all timber.

TABLE 1.—*Board feet, log scale, contained in logs measured according to the Doyle log rule*

Diameter small end inside bark (inches)	Length in feet										
	6	7	8	9	10	11	12	13	14	15	16
	Board feet										
6	1	2	2	2	2	3	3	3	3	4	4
7	3	4	4	5	5	6	7	7	8	8	9
8	6	7	8	9	10	11	12	13	14	15	16
9	9	11	12	14	16	17	19	20	22	23	25
10	13	16	18	20	22	25	27	29	31	34	36
11	18	21	24	28	31	34	37	40	43	46	49
12	24	28	32	36	40	44	48	52	56	60	64
13	30	35	40	46	51	56	61	66	71	76	81
14	37	44	50	56	62	69	75	81	87	94	100
15	45	53	60	68	76	83	91	98	106	113	121
16	54	63	72	81	90	99	108	117	126	135	144
17	63	74	84	95	106	116	127	137	148	158	169
18	73	86	98	110	122	135	147	159	171	184	196
19	84	98	112	127	141	155	169	183	197	211	225
20	96	112	128	144	160	176	192	208	224	240	256
21	108	126	144	163	181	199	217	235	253	271	289
22	121	142	162	182	202	223	243	263	283	304	324
23	135	158	180	203	226	248	271	293	316	338	361
24	150	175	200	225	250	275	300	325	350	375	400
25	165	193	220	248	276	303	331	358	386	413	441
26	181	212	242	272	302	333	363	393	423	454	484
27	198	231	264	298	331	364	397	430	463	496	529
28	216	252	288	324	360	396	432	468	504	540	576
29	234	273	312	352	391	430	469	508	547	586	625
30	253	296	338	380	422	465	507	549	591	634	676
31	273	319	364	410	456	501	547	592	638	683	729
32	294	343	392	441	490	539	588	637	686	735	784
33	315	368	420	473	526	578	631	683	736	788	841
34	337	394	450	506	562	619	675	731	787	844	900
35	360	420	480	541	601	661	721	781	841	901	961
36	384	448	512	576	640	704	768	832	896	960	1,024
37	408	476	544	613	681	749	817	885	953	1,021	1,089
38	433	506	578	650	722	795	867	939	1,011	1,084	1,156
39	459	536	612	689	766	842	919	995	1,072	1,148	1,225
40	486	567	648	729	810	891	972	1,053	1,134	1,215	1,296

As buyers' specifications generally call for lengths from 8 to 16 feet with a small proportion 8 and 9 feet long, it is generally advantageous to cut the logs not over 12 feet in length, since in long logs the diameter at the small end is proportionately less. In some cases, however, it will be necessary to cut them longer in order to include all of the tree that is salable. This is often the case with open-growth trees, which commonly yield only one log (fig. 2). Since the thickness of the bark on the logs amounts to 1 or 1½ inches, a deduction of 2 to 3 inches should be made from the outside diameter of the tree to get the diameter inside the bark. An allowance of about 3 inches additional on the length of each log is necessary for cutting into log lengths.

Twelve inches at the small end is usually the smallest log size acceptable; therefore, smaller diameters should not be included.

In making an estimate of the timber it will be found convenient to make a list of all logs, showing the small end diameter and the length of each log in each tree, with a space for the quantity of each log in board feet to be filled in later. The following list shows how the log scale may be entered in this way. By classifying the different logs according to grade, their approximate value may be ascertained. If it is not desired to separate the logs into grades, the number of board feet may be entered in a single column.

TABLE 2—*Method of entering logs*

	Grade	Length (feet)	Diameter (inches)	Scale, board feet, by log grade			
				No. 1 veneer	No. 1 lumber	No. 2 lumber	No. 3 lumber
Tree No. 1:							
Butt log	No. 1 lumber	14	18		171		
Second log	No. 2 lumber	12	14			75	
Tree No. 2: Butt log	No. 1 lumber	16	13		81		
Tree No. 3:							
Butt log	No. 1 veneer	12	20	192			
Second log	No. 1 lumber	10	12		40		

A rough valuation of the logs may be obtained by adding together the scale in board feet for each diameter class of each log grade and multiplying by the values given in Table 3 of this bulletin. The freight cost can also be estimated by using the approximate log weights given in Table 4. In preparing such a list of logs one should measure or estimate the diameters and lengths carefully in order to obtain dependable results.

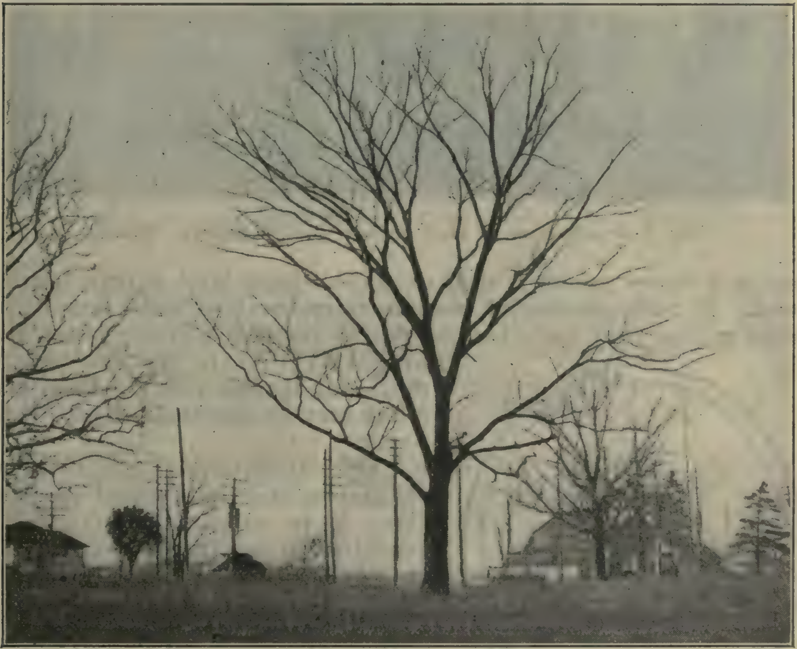

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Fig. 2.—Open growth type of black walnut

The large tree at the left in Figure 3 should yield one high-grade butt log and possibly one other high-grade log. The tree at the left of this one will yield one long log or possibly two short ones of good quality. The tree in the middle has one butt log of high quality and one log of a lower grade. The one at the extreme right will yield one small log of doubtful quality.

Some of these trees are being used to support the fence wire in the foreground. This may result in the buyer's placing some of the butt logs in a lower grade if nails or staples have been driven into the wood. If nails or staples have been in the tree for a number of years, so that they have become deeply imbedded in the wood, they are likely to ruin the saws at the mill, and therefore a log from such a tree may be rejected entirely by the buyer.

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Fig. 3.—Small grove of black walnut trees in pasture. Illinois

Very defective logs are not merchantable, and the general specifications given on page 2 should be consulted to determine what logs are acceptable.

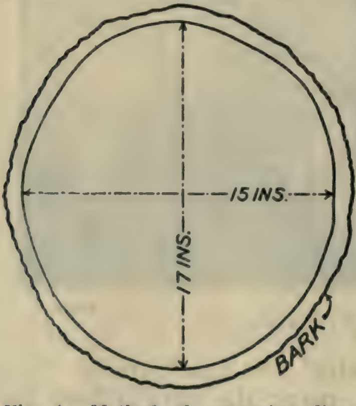

Fig. 4.—Method of measuring diameters of logs that are not round. An average is taken of the long and short diameters measured at right angles to each other. In this instance the diameter is 16 inches

SCALING LOGS

It is, of course, much easier to determine the contents of the logs after they have been cut. The diameter at the small end inside the bark can then be determined accurately with a rule, as also the length. Before cutting the log into lengths the instructions given under "How to cut walnut trees" should be consulted.

Where the log is not round at the small end the usual method of measurement is to split the difference between the longest and shortest diameters taken at right angles to each other, as shown in Figure

4. Since the long diameter in this case is 17 inches and the short diameter 15 inches, the diameter of the log is counted at 16 inches. If the log is 15 inches one way and 15½ inches the other, or if it is 15 inches one way and 16 inches the other, it is counted as 15 inches; if 15½ one way and 16½ the other, it is counted as 16 inches.

If the diameter of a log at the small end is noticeably larger than at any other point throughout its length, it is customary to take the smallest diameter, as the amount of lumber than can be sawed from a log is determined by its smallest diameter.

Table 1, giving the amount in board feet according to the Doyle rule can be applied in the same way for logs as for standing timber.

Additional information on scaling logs and estimating standing timber will be found in Farmers' Bulletin 1210, United States Department of Agriculture, "Measuring and Marketing Farm Timber."

FINDING A MARKET

Before dealing with the log buyer, timber owners should prepare a statement concerning their timber, giving location, distance from highway and railroad, and amounts of different sizes and grades of logs as accurately as can be determined. Following is a sample description:

Timber one-fourth mile from good road, 4 miles northeast of Jonesville, Brown County, Ind., 3½ miles by road from White's siding on Baltimore & Ohio Railroad.

Veneer grade:
  1 log 19 inches in diameter at small end, 10 feet long.
  2 logs 16 inches in diameter at small end, 12 feet long.
No. 1 lumber grade:
  2 logs 17 inches in diameter at small end, 14 feet long.
  4 logs 16 inches in diameter at small end, 12 feet long.
  1 log 16 inches in diameter at small end, 14 feet long.
  1 log 14 inches in diameter at small end, 10 feet long.
No. 2 lumber grade:
  2 logs 14 inches in diameter at small end, 13 feet long.
  1 log 12 inches in diameter at small end, 10 feet long.
  2 logs 10 inches in diameter at small end, 12 feet long.

This statement may be mailed to several firms which may be interested in purchasing the timber.[7]

Where there is available a sufficient quantity of high-grade black-walnut timber to interest the large walnut manufacturer, the farmer should deal directly with him or his representative. Where there is not enough to interest the large mill, the best that can be done may be to sell the timber to the jobber who buys up walnut from farmers throughout the community and sells to manufacturers of walnut lumber and veneer. It is, of course, advisable wherever possible to deal with the manufacturer directly. It may be more advantageous to sell to the large mill than to the small sawmill, which generally turns out a lower grade product and can not afford to pay as much for high-grade logs.

Some of the large mills have local representatives who purchase logs for them whenever there is opportunity. More often, however, the mills have regular salaried buyers who travel throughout the country districts estimating, scaling, and buying. Where there is a sufficient quantity of walnut available, such buyers will make a special trip to estimate and make an offer on the timber. It will often, therefore, be of advantage to the prospective seller to determine in a very rough way how much walnut there is available for sale in his vicinity, and to make this known to the mills he addresses, so that he will stand a better chance of obtaining the services of a mill buyer.

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[7] A list of firms which purchase walnut will be furnished on request by the U. S. Forest Service, Washington, D. C.

Although the railroads charge for a shipment according to weight, there is a fixed minimum charge for a carload, and therefore a small shipment of logs may carry an excessive freight cost. It is often advantageous for two or more farmers to combine their logs in one car.

Thus there are several advantages to be gained in marketing timber in large quantities: (1) Buyers can afford to give a better price where they handle a large quantity in one neighborhood; (2) there is more likelihood of interesting several buyers, and competition among them may result in higher prices; (3) the logs can be shipped in full carload lots, keeping the freight cost at the minimum.

Where several farmers in a neighborhood have marketable walnut they will often find it advantageous to deal with the buyer collectively, for a large quantity of timber can be disposed of more profitably than can several small quantities. Where farmers join together for the purpose of selling their timber they may wish to form a temporary organization for this purpose.

The responsibility for starting such an organization is generally assumed by one or more owners of walnut timber who are anxious to sell. These owners first get in touch with others who have timber to dispose of. The county agricultural agent can usually assist by getting up a list of those farmers who have walnut timber for sale. Owners may be asked to submit a list of their trees or logs, giving sizes and quality, for the purpose of determining the approximate amount of timber available.

The county agent may be able to help by calling a meeting of those farmers who have walnut timber and who are interested in selling it. In order to give more definite purpose to the meeting, some one should assume the duty of collecting market information and presenting it to the group. Wherever an extension forester is available he could help by explaining the methods of handling walnut timber, the sizes and quality of logs for which there is a demand, and perhaps by suggesting plans for the disposal of the timber.

At the meeting an inventory should be made of the total amount of timber available. This information can be forwarded to walnut-log buyers in order to interest them to inspect the timber and make offers on it. The buyers' offers will be made on each parcel of timber as it stands or cut into logs in the woods or delivered at the railroad. If several farmers arrange to sell their timber at the railroad, the logs of each owner should be plainly marked and piled separately.

The farmers should arrange with some one who is familiar with the measuring and grading of logs to represent them at the time when the buyer makes his inspection. He should make a check scaling and grading of all of the logs, keeping a separate record for each owner.

METHODS OF SELLING

Two general forms of sale are usually open to the timber owner—a lump-sum offer and a price by the board foot.

Lump sum.—The lump sum or price for the entire lot is often preferred by the buyer, because he is better qualified than the owner to determine very closely the quantity and value of the timber. On the other hand, selling for a lump sum eliminates the uncertainties accompanying measurement of the logs, and if the owner has obtained a knowledge of the approximate quantity and value of his timber and has secured bids from several buyers, this may be the most advantageous method of sale.

One disadvantage of selling standing timber by lump sum is that the buyer unless restricted may cut young trees, adding little, if anything, to the price offered. By saving the younger, fast-growing trees a future crop of walnut timber can be assured. If the younger growth is to be spared, there should be a definite understanding as to which trees are to be taken. This may be a stipulation in writing that trees below a certain diameter limit shall not be cut; it is preferable, however, that each tree that is to be cut be given a distinctive mark, so that there will be no misunderstanding on the part of the cutters. It is customary to "blaze" each tree to be cut at a place above the saw cut (conveniently at breast height) and also near the ground. This will leave a record on the stump and on the first log.

Board foot.—In selling according to the amount in board feet the price paid per thousand feet should vary with the diameters of the logs. This should be according to a fixed scale of prices which will specify the amount to be paid per thousand board feet for each diameter size or diameter class, for example, the diameter classes as given on page 14. To avoid later misunderstandings the seller should keep a record of the prices agreed upon.

A common method is to sell the standing timber with the understanding that it will be paid for according to the log scale after it is felled and cut into log lengths. This method of sale should work to the advantage of the seller if the felling and cutting are carefully done.

The owner should accompany the log buyer when the logs are measured. In order to satisfy himself as to the correctness of the scale, the owner may number each log and enter on a sheet of paper the diameter and length of each recorded by the buyer. A thorough familiarity with the method of measuring logs, specifications, and prices for different sizes and grades will be of great help in selling the timber to good advantage.

The farmer may sometimes have the option of disposing of his timber standing, cut into log lengths on the ground, or delivered at the railroad or on board cars. He will generally find it to his advantage to do the work of cutting, hauling, and loading on cars, if he has the necessary equipment, for thereby he will get the extra price allowed. This work may well be done during the winter or at times when other farm work is not pressing.

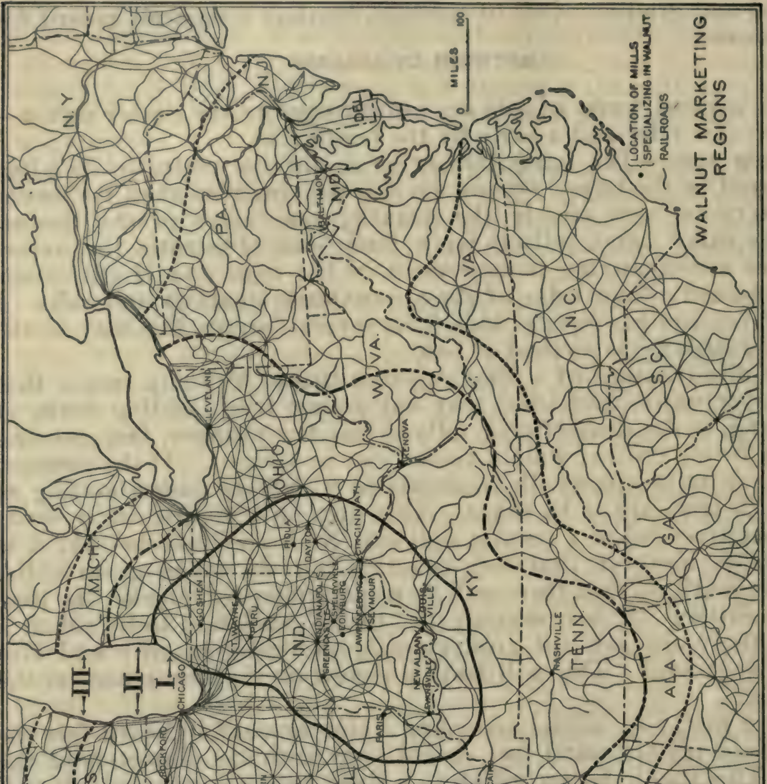

Fig. 5.—This map indicates the relative advantages of different regions and localities for marketing walnut. In Area I no point is farther distant than 50 miles from a mill using walnut; in Area II no point is farther distant than 100 miles; and in Area III the greatest distance from a mill purchasing walnut is about 150 miles. The more conveniently the timber is located to the railroad and the nearer to the mill the better the price it should bring

Usually it is undesirable to sell logs subject to inspection at the mill, since this is likely to lead to disputes over the log scale, possibly to the rejection of logs after they have been hauled long distances, and to other misunderstandings.

A commendable plan of purchase by the board foot is as follows: An inspector is sent to measure the logs at the railroad right-of-way, and as soon as they are measured a check made out to the seller is deposited in his bank. After the logs have been shipped, the railroad company's receipted bill of lading is delivered to the bank. The bank is then automatically authorized to turn the money over to the seller.

For aid in determining the possible profits from a logging venture consult figures given on page 19. These are estimated costs used by walnut-timber buyers for cutting, hauling, and loading on cars.

Prices.—The prices paid for black-walnut logs vary widely, depending mainly on their quality, size, and location. Logs at the mill naturally bring higher prices than logs in the woods or delivered at the railroad. Since freight is a large item of cost the value of standing timber will depend greatly on the distance from the mill where it is to be converted into lumber or veneer. Figure 5 gives the location of mills which specialize in black walnut. Distances from mills are indicated by the three areas shown. In Area I no place is farther distant than 50 miles from a mill, in Area II no place is farther distant than 100 miles, and in Area III the greatest distance from a mill is about 150 miles. In Area I, therefore, the value of standing timber is in general higher than in Areas II or III and in Area II higher than in Area III. Outside of these areas the value on the average is, of course, even less.

Since values vary so greatly with distances from the standing timber to the railroad and from railroad to mill, prices at the mill only will be given. From these the values at the railroad and in the woods may be roughly approximated by referring to the sections on log weights and freight rates and costs of felling and hauling.

There is considerable range in the prices at the mill quoted by different firms. This range is in part due to the fact that some firms require a somewhat better quality of logs than others. In sections of the country where the logs run poorer in quality firms must accept a poorer grade of logs, and the price is correspondingly lower. Where the timber is scattered and far from the mill the general tendency is also toward a lower price.

Table 3 indicates the price range for logs of different sizes and grades. The figures given apply to logs in carload lots at the mill. Prices for No. 3 grade logs are not given, because when they are purchased the price is fixed at whatever the purchaser wishes to pay for them. The great variation in price for No. 1 lumber logs is due largely to the different quality of logs included in this grade by different firms. Those which manufacture lumber only will naturally include better logs in the lumber grade than those which make both lumber and veneer, and have separate veneer and lumber log grades.

These prices are a little higher than those prevailing soon after the World War and are very much more than those paid before the war. If the present demand for walnut furniture is maintained it is probable that the prices for walnut timber will increase with its growing scarcity. In any event, because of the value of the wood for a number of uses the price is not likely to drop.

TABLE 3.—*General range of prices paid at the mill by large walnut mills in 1924, for different sizes and grades of black-walnut logs in carload quantities*

Diameter at small end of log inside bark (inches)	Prices per 1,000 board feet Doyle log scale, by log grades			Diameter at small end of log inside bark (inches)	Prices per 1,000 board feet Doyle log scale, by log grades		
	Veneer [1]	No. 1 lumber [2]	No. 2 lumber [3]		Veneer [1]	No. 1 lumber [2]	No. 2 lumber [3]
12 and 13		$50–$100	$30–$65	22 and 23	$125–$225	$65–$150	$50–$75
14 and 15		60– 110	30– 70	24 and 25	150– 250	65– 175	50– 75
16 and 17	$75–$150	65– 120	40– 75	26 and 27	150– 275	65– 175	50– 75
18 and 19	100– 175	65– 125	40– 75	28 and 29	175– 300	65– 200	50– 75
20 and 21	100– 200	65– 125	40– 75	30 and over	200– 300	65– 200	50– 75

[1] Also sometimes called "Prime Veneer."
[2] This grade is often termed "Good" or "Good Mill." See specifications, page 3.
[3] Sometimes designated as "Common."

Logs with special figure, such as curly and wavy grain, should bring higher prices than plain logs, especially large logs with such figure. The price depends very largely on the extent and quality of the figure and may run as high as $500 a thousand board feet or even higher for very large, highly figured logs. As a general rule only the experienced log buyer is able to recognize figured logs, so that in most cases he must be depended on to give a fair price for such logs when they are discovered. Figured stumps generally bring from $250 to $350 a thousand board feet when sold by the log scale. If very large and well figured, they may bring as much as $600 a thousand board feet or even more for very choice material. It should be remembered in this connection, however, that only those stumps are of special value, that have a sufficient amount of the valuable crinkle or ripple-mark figure and are capable of being converted into high quality veneer. As already stated, their value is a matter which must usually be left to the log buyer.

The walnut burl is a peculiar growth which is often of great value for the manufacture of veneer. The burl generally has the appearance of a huge wart. The best ones are usually turnip-shaped, and typical specimens are covered with little conical spines. As a general thing only the so-called "root burls," which grow on the stump or root of the tree, are valuable; those higher up on the trunk or on large limbs are generally full of cavities. A burl should contain sound, solid wood in order to be of value for cutting into veneer. Burls of high value have been found on the roots below the surface of the ground; they are very rare, however. Burls are generally sold by weight and the price paid is usually 10 or 15 cents a pound.

HOW TO CUT BLACK WALNUT TREES TO BEST ADVANTAGE

LOGS

The quality and value of the log frequently can be increased by care in cutting the tree into log lengths after it is felled. The important thing to keep in mind is to cut the merchantable portion of the tree into such lengths that the logs will be of the highest quality and at the same time contain the largest quantity of merchantable material. Generally the logs should be cut at a crook, crotch, or knot wherever practicable, in order to get as straight and clear lengths as possible. For instance, the tree shown in Figure 6 should be cut at the large knot which is about 10 feet above the ground. Another log can probably be obtained above this knot.

One should avoid including extra length in logs that taper rapidly at the upper end, as this will reduce the scale of the log. For instance, a certain log cut 16 feet long has a diameter of 14 inches at the small end because of excessive taper in the last 2 feet, and thus contains 100 board feet according to the log-scale table. At a length of 14 feet from the large end it measures 16 inches in diameter. If it had been cut to this length, it would scale 126 board feet (over one-fourth more) and should bring $15 a thousand board feet more

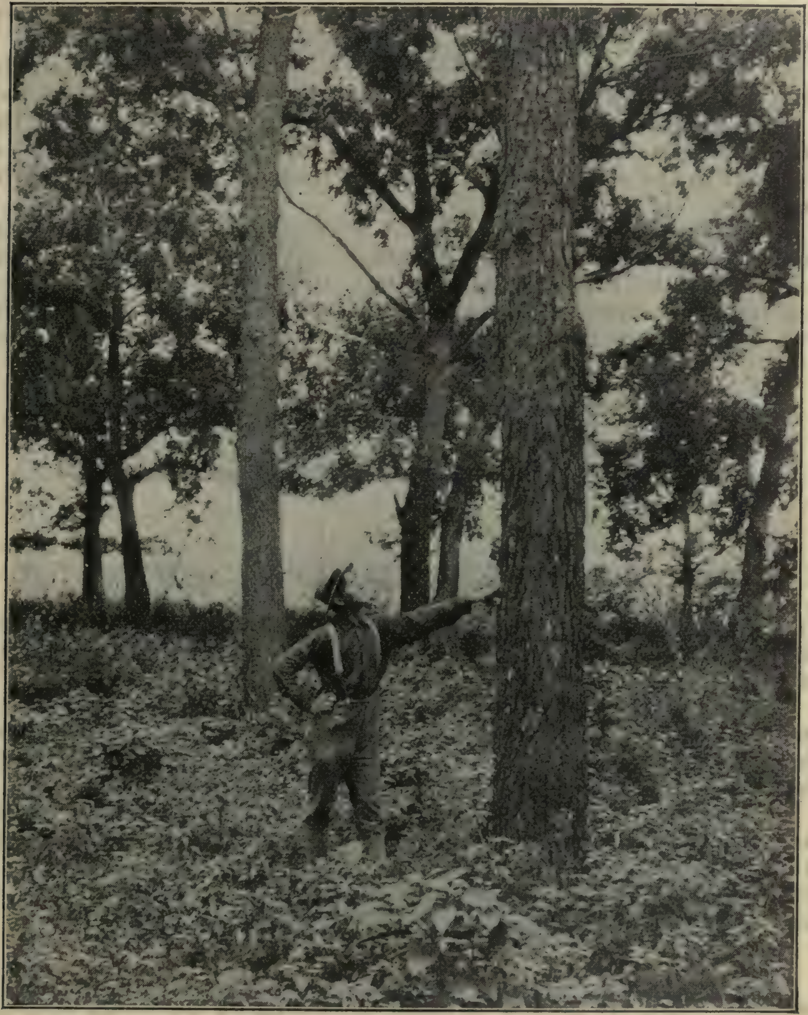

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Fig. 6.—This black walnut tree when sawed into log lengths should be cut at the large knot located about 10 feet from the ground

because of the greater diameter. This is illustrated by the sketch in Figure 7.

This does not mean that it is always advisable to cut short logs. As already stated, firms generally specify that there shall be not more than a certain percentage of logs under certain lengths.

Some log buyers take the diameter measure of long logs at some specified distance from the small end. This method of measurement is commendable because, while avoiding loss from taper and corresponding loss in diameter, it takes full advantage of length of log.

All logs are required to be cut at least 2 inches longer than the even foot; for instance, a log 9 feet long must measure at least 9 feet 2 inches. This is to allow for squaring the ends of the boards at the mill. Cutting the logs more than 4 to 6 inches over the even foot is wasteful to the seller because the extra length does not increase the log scale.

In felling the tree the cut should be made as near the ground as possible in order to get the advantage of the more valuable large-sized material. Figure 8 shows a tree properly felled so that there is a minimum amount of waste. Where the stump is of value, the tree should be cut at the roots as described in the next section. For this reason it is advantageous to have the buyer look over the timber before it is felled so that he may indicate any stumps which may be of value.

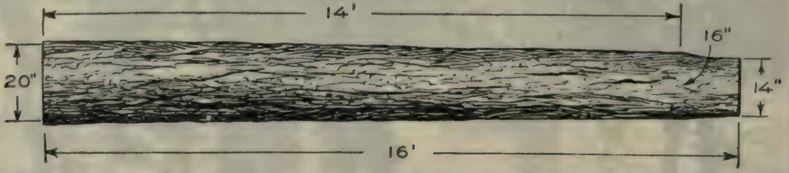

Fig. 7.—How a log 14 inches in diameter at the small end, 16 feet long, and containing 100 board feet, might have been cut into a log 14 feet in length, 16 inches in diameter at the small end, containing 126 board feet

Care should be exercised in felling walnut, especially if there is a large crotch, as the wood is inclined to split. If the crotch strikes the ground with considerable force it may split below the fork and extend a long distance into the large trunk, causing much loss.

The side on which the tree is to be felled should be deeply undercut; otherwise splinters are likely to be pulled out of the butt log, which lessens the value of that log. Buyers generally make the same deductions for logs with splinter pull as for logs with hollow or rotten centers.

STUMPS AND CROTCHES

Figured stumps should be dug up in order to include all of the valuable wood. If the tree is felled by cutting off the roots, this will save much labor in getting the stump out of the ground. This can usually be done without damage to the stump. After the stump has been gotten out, the root spurs along the side should be cut off nearly flush with the surface of the trunk and the base squared off by sawing. Only the solid portion of the stump can be used, and the root spurs if left on the trunk will cause much inconvenience in handling and shipment. The proper method of trimming stumps is shown in Figure 9. Crotches are often of special value for veneer and should be cut about the same length as stump wood, as described on page 4.

STORING CUT TIMBER

Logs should not be left lying for a long time on the ground; and if the ground is moist, they should not be in contact with the earth for more than about a week. They should be raised at least 6 inches off the ground and protected as much as possible from excessive heat of the sun by being piled under the shade of trees or under a temporary shelter. Unless the logs are to be shipped at once, the ends should be painted to help prevent decay and to retard their drying out, thus helping also to keep them from checking. If the ends of the logs are checked at the time of felling, it is customary for the cutters to make a blunt cut with a wedge across the outer ends of the check. This helps to prevent the check from extending still farther.

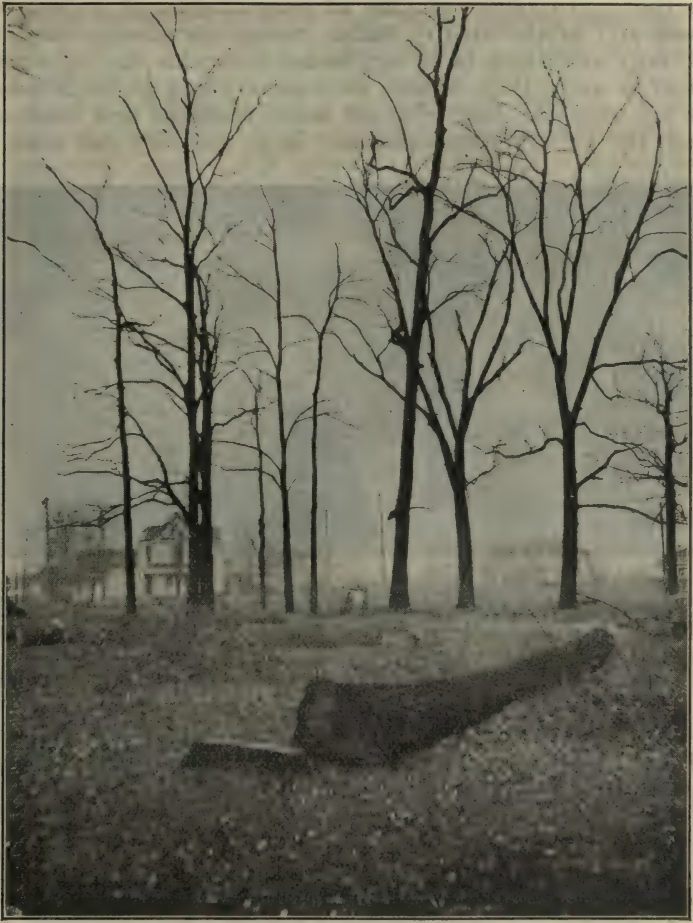

Fig. 8.—A black walnut tree felled with the cut close to the ground in order to include in the log as much as possible of the valuable large sized timber

LOG WEIGHTS AND FREIGHT RATES

Since, as already stated, the value of black-walnut timber of the same size and quality varies greatly with the distance from the market, it is advantageous for the prospective seller to be able to figure the costs from the tree to the factory even though such costs can only be approximated. Freight costs constitute a large item in marketing walnut logs, particularly if the distance is great. Table 4 gives the approximate weights of several sizes of walnut logs in the green and in the air-dry state. Since the air-dry condition is reached only after logs have lain under favorable drying conditions for a year or more, these figures serve merely as a guide in determining the log weights. Logs dry out much faster at first than as they approach the air-dry condition, and large logs dry out much more slowly than small logs. Small logs might lie as long as a week even under favorable drying conditions and still be practically green, and larger logs two or three weeks without drying out appreciably.

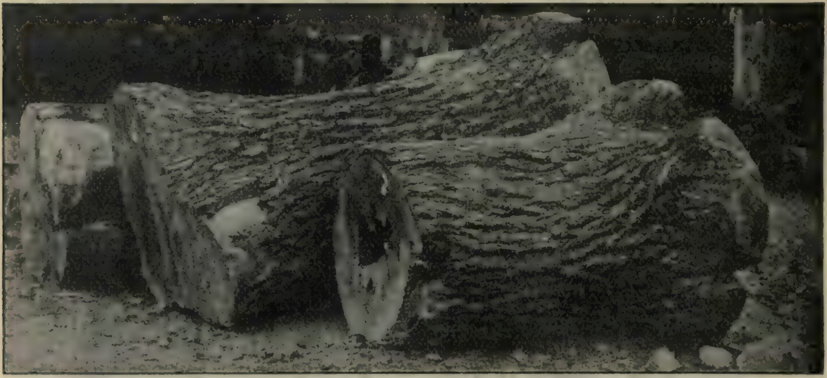

Fig. 9.—Walnut stumps with roots properly trimmed. The big one with a crotch is particularly valuable for making veneers. The stump in the foreground has a hollow center. This does not necessarily spoil an otherwise valuable veneer log for, unless the hole is too large, the log can be mounted on the lathe and the veneer cut from it

In using Table 4 multiply separately for each diameter size the total amount of timber expressed in thousands of board feet by the weight per 1,000 board feet for that diameter size. Then add the amounts of all diameter sizes together to get the total weight.

Table 4.—*Approximate weights of black walnut logs*

Diameter of log inside bark at small end	Weight per 1,000 board feet log scale, Doyle rule		Diameter of log inside bark at small end	Weight per 1,000 board feet log scale, Doyle rule	
	Green	Air dry		Green	Air dry
Inches	*Pounds*	*Pounds*	*Inches*	*Pounds*	*Pounds*
12	11,900	8,200	19	8,000	5,500
13	10,900	7,500	20	7,750	5,300
14	10,200	7,000	21	7,600	5,200
15	9,500	6,500	22	7,400	5,100
16	9,000	6,200	23	7,250	5,000
17	8,600	5,900	24	7,100	4,900
18	8,300	5,700			

Following is an example of the use of the weight table:

From the list of logs (see p. 7), prepared to show the scale of each log, add together the scale of all the 12-inch diameter logs, all of the 13-inch, etc. Suppose that altogether there are 1,500 board feet of logs measuring 12 inches at the small end. Logs of this diameter class will, in the green condition, average about 11,900 pounds for each 1,000 board feet. This would make the total weight of the 12-inch logs 17,850 pounds. By obtaining the weight in this way for each diameter size and adding all together, the total weight is obtained. This is, however, only a rough method of determining the weight and freight cost, since logs of the same diameter and length will vary considerably in weight.

By ascertaining from the local railway agent the freight rate to the prospective market, the approximate freight cost can be determined. When the mills pay the freight, the smallest quantity acceptable as a carload is generally 3,000 board feet log scale for logs which are at least of average size and quality. A smaller quantity will be accepted by some firms if the logs are of unusually high grade or if they are figured.

A freight car will hold from 4,000 to 7,000 board feet of logs, depending mainly on the diameter size of the logs. The smaller the logs the less the quantity in board feet that the car will hold.

COSTS OF FELLING AND HAULING

The following costs are those generally used by timber buyers and are given for the purpose of helping the owner to determine how profitable it will be for him to do the cutting and hauling.

Felling costs are generally figured at from $5 to $10 a thousand board feet. At the usual wage scale they should be much less for the farmer who fells his own timber. Hauling logs to the railroad is an important factor in marketing walnut, and the cost varies with the distance, with the character of the country over which the hauling is to be done, and with the kind of roads. Three hundred board feet of average-size logs weighs about 2,500 pounds and is considered a large wagonload. A large motor truck such as is used by loggers will carry much more, however, and make more frequent trips. Under fairly good hauling conditions the cost of a 5 to 10-mile team haul is generally figured at from $15 to $30 a thousand board feet, or at the rate of about $3 a mile for each 1,000 feet. If the timber is scattered and the country rough, the cost may amount to $4 per thousand per mile.

Although the costs of the different operations from the standing timber to the mill yard may vary considerably, the following may be considered as average, per 1,000 board feet Doyle log scale:

Felling	$5 to $10
Hauling and loading on cars	15 to 30
Freight	15 to 20
Total	35 to 60

This means that if the farmer cuts the trees, hauls the logs a distance of 5 to 10 miles to the railroad, and loads them on the cars, he should get from $20 to $40 more for each 1,000 board feet log scale that he handles than he would for the timber standing.

These costs are high for cutting and hauling logs, but this is because walnut is so scattered. Commonly only one or two trees may be found in a place and the different trees so widely separated that they must be transported for long distances. The costs given are those which prevailed during and shortly after the World War and are fairly representative of present conditions.

SOURCES OF ADDITIONAL INFORMATION

There are several possible sources from which the farmer may obtain valuable assistance in marketing his timber. The county agricultural agent and the forestry department of his State (where there is such a department) may be able to advise him how to cut and measure the timber. They may also be able to help him dispose of it advantageously. The Forest Service, United States Department of Agriculture, will furnish a list of firms purchasing walnut logs and any available detailed information which will be helpful in marketing these timber products.

The following Farmers' Bulletins can be obtained free of charge from the United States Department of Agriculture, Washington, D. C., as long as the supply lasts:

Farmers' Bulletin:
- 1210. Measuring and Marketing Farm Timber.
- 1100. Cooperative Marketing of Woodland Products.
- 1117. Forestry and Farm Income.

Farmers' Bulletin—Continued.
- 1392. Black Walnut for Timber and Nuts.
- 1123. Growing and Planting Hardwood Seedlings.
- 1177. Care and Improvement of the Farm Woods.

These bulletins may also be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents each. The following are no longer available for free distribution, but may be purchased as above for the prices given in each case. Remittance must be made by money order or can be sent in coin at the sender's risk:

Department of Agriculture Bulletins:
- 909. Utilization of Black Walnut. 30 cents.

Department of Agriculture Bulletins—Con.
- 933. Black Walnut, Its Growth and Management. 20 cents.

The following is a list of State forestry departments in the important walnut-producing States:

Illinois.—State Forester, State Natural History Survey Division, Urbana.
Indiana.—State Forester, Department of Conservation, Division of Forestry, Indianapolis.
Iowa.—State Forestry Commissioner, Des Moines.
Kansas.—State Forester, Kansas Agricultural College, Division of Forestry, Manhattan.
Kentucky.—Commissioner, Commission of Agriculture, Labor, and Statistics Frankfort.
Maryland.—State Forester, State Department of Forestry, 815 Calvert Building, Baltimore.
Michigan.—State Forester, Lansing.
New Jersey.—State Forester, Department of Conservation and Development, Division of Forestry, Trenton.
North Carolina.—State Forester, Geological and Economic Survey, Raleigh.
Ohio.—State Forester, Department of Forestry, Agricultural Experiment Station, Wooster.
Pennsylvania.—Secretary, Department of Forests and Waters, Harrisburg.
Tennessee.—State Forester, State Bureau of Forestry, Nashville.
Virginia.—State Forester, Charlottesville.
West Virginia.—Chief Game Protector, Game and Fish Commission, Buckhannon.
Wisconsin.—Superintendent of State Forests and Parks, State Conservation Commission, Madison.

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June 26, 1925

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1460

SIMPLE PLUMBING REPAIRS IN THE HOME

1862 1889

PLUMBING often gets out of order, and upon prompt attention to the little repair jobs depends its smooth, satisfactory operation. This bulletin describes simple ways of doing little things, with the aid of a few simple tools, to keep home plumbing in good working order.

Washington, D. C. September, 1925

SIMPLE PLUMBING REPAIRS IN THE HOME

By George M. Warren, Associate Hydraulic Engineer, Bureau of Public Roads

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HOW BEST to make small plumbing repairs is a problem that comes to most householders. The employment of a plumber may be difficult or too costly. In such situations a little time and knowledge on the part of the householder often saves much delay, trouble, and expense. Repairs made by the householder may not always be so thorough and workmanlike as those made by an experienced plumber, but they are valuable in emergencies and for most of the simple jobs are about as satisfactory. Where local or State plumbing regulations are in force and extensive repairs or alterations are contemplated, the householder should make sure that the work is duly authorized and is done by a properly qualified plumber.

In making repairs it is often necessary to tighten or to loosen a screw or nut, and the householder is sometimes uncertain in which direction it should be turned. To screw or tighten an ordinary right-hand screw, nut, or bolt, first think of the head of the part to be turned as being the face of a clock and the screw driver or wrench as being the shaft which turns the clock hands, and then rotate the tool from left to right or in the same direction the clock hands move. Conversely, to unscrew or loosen rotate the tool from right to left or in the direction opposite to clockwise. Small, brass screws and stems are easily twisted off and rendered useless, especially if a large tool is used to turn them. Undue strain should be avoided, as it may result in the part or parts being broken at an unfortunate time.

FAUCETS

SEAT WASHERS

Loose or rough-edged washers cause vibrating or rattling noises; worn washers cause leakage. Moderate force on the handle of a faucet in good repair should stop all flow and drip. Figure 1 shows an ordinary, half-inch, tee handle, compression faucet which closes against the pressure of the water. To replace the seat washer, shut off the water to the faucet. Unscrew the cap nut with a monkey wrench. (Placing cloth or thick paper between the jaws of the wrench saves marring the cap nut.) Take hold of the faucet handle and unscrew the stem from the body of the faucet. With a screw driver remove the washer screw at the bottom of the stem. This screw is often hard to start. One or two drops of kerosene and lightly tapping the head of the screw may help to loosen it in the stem. Use strong even force on the screw driver, the blade of which should have a good square edge to fit the slot. The head of the screw often splits before the shank of the screw turns in the stem, because of corroded and weakened condition. If it splits, deepen the slot in the head with a hacksaw, cutting a little into the shank of the screw. No harm is done if the saw cuts slightly into the stem of the faucet. The washer screw may now be turned with a small screw driver. Replace the old washer with a new one, replace the washer screw, screw the stem into the faucet, and screw down the cap nut. Hard fiber composition washers one-eighth to three-sixteenths inch thick and costing about 10 cents a dozen are in general use and are suitable for both hot and cold water faucets. A few washers of the needed sizes should be kept in the home. If none is at hand, a temporary washer may be cut from a piece of leather, rubber, or sheet packing. Leather is preferable on cold-water faucets and rubber on hot-water faucets.

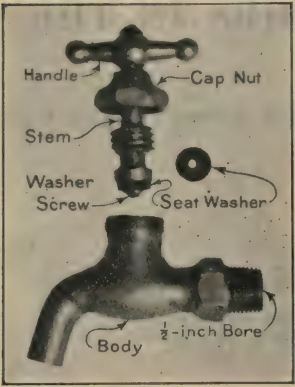

FIG. 1.—Compression faucet

Figure 2 shows an ordinary, three-eighths inch, 4-ball handle, compression faucet for a washstand. To replace the seat washer, shut off the water to the faucet and open the faucet one or two turns of the handle. With a monkey wrench on the hexagonal part of the stuffing box unscrew the stuffing box from the body of the faucet. Lift out the stem, replace the old washer, as previously described, with a new one, and screw the stuffing box into the body.

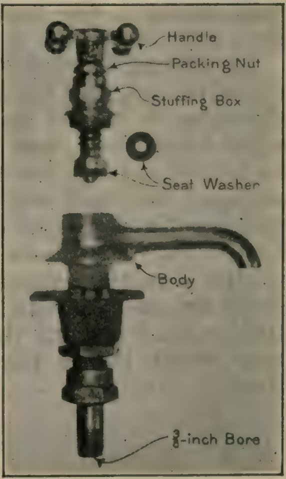

FIG. 2.—Compression faucet for a washstand

A worn washer with constant leakage over the seat of a compression faucet together with grit lodging there, often causes the seat to become cut, nicked, and grooved. The trouble occurs more often in hot-water faucets than in cold. Such seats can easily be reground or squared with a simple seat dressing tool, of which two types are shown in Figure 3 A and B. A seat dresser with four cutters for different-size faucets costs about $2 and its use saves buying new faucets. To dress the seat of a faucet, unscrew the stem from the body of the faucet, as above described. Screw the adjustable, threaded cone of the tool (see fig. 3 A) down into the body of the faucet as shown in Figure 3 C, thus centering it over the seat. With the hand as shown in Figure 3 D, gently rotate the wheel handle at the top of the tool several times, and the cutter on the bottom of the stem squares the seat. Turn the faucet bottom side up and shake out the cuttings. Reassemble the faucet and turn on the water to wash out any remaining cuttings.

Seat washers are subject to damage from metal filings left in newly installed water pipes. A good plumber, before screwing up a piece of pipe, always stands the pipe on end and raps it with a hammer to clear the bore.

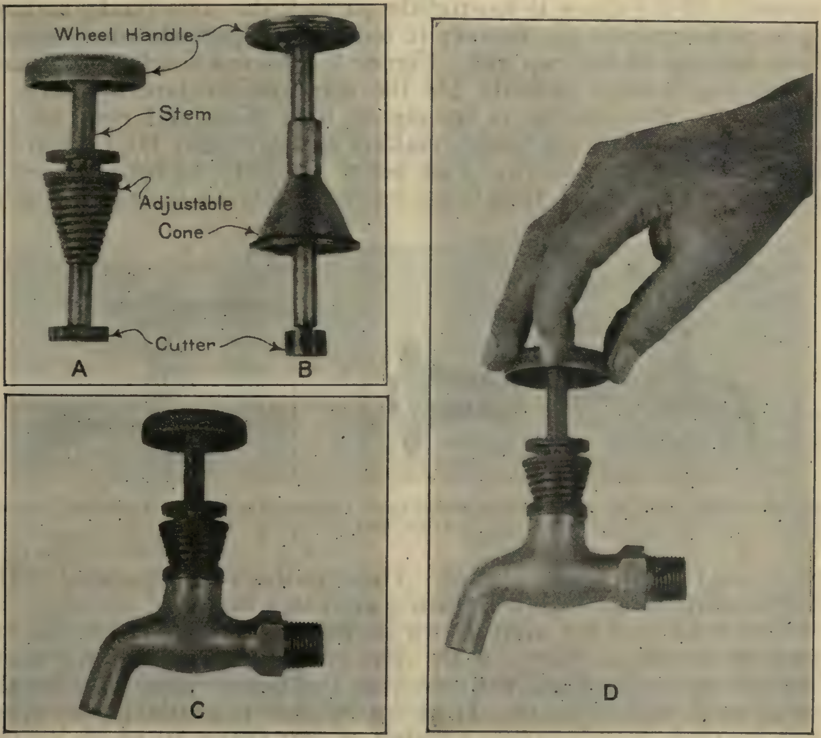

Fig. 3.—Faucet seat dressers: A, dresser with inside adjustable cone; B, dresser with outside adjustable cone; C, dresser A screwed into a compression faucet; D, rotating the wheel handle and cutter

Figure 4 A shows an ordinary half-inch lever-handle Fuller faucet which closes with the pressure. As shown in Figure 4 B, the bottom of the spindle is eccentric, so that slight turning of the handle moves the rubber ball to and from the beveled seat. To replace the ball shut off the water to the faucet. Unscrew the body from the tailpiece with the hands or with a monkey wrench on the hexagonal part of the body of the faucet. It may be necessary to apply a wrench to the hexagonal nut on the tailpiece and press the wrench downward to prevent unscrewing the tailpiece. Unscrew the stem nut which holds the brass cap and rubber ball on the stem. Put on

a new ball and replace cap and nut. Red rubber balls are considered to be better than black balls for hot-water faucets. Avoid using too large a ball, as swelling of the rubber may hinder the flow. Screw the faucet into the tailpiece. Just before the joint closes or "makes up," wrap a little string packing or candle wicking around the thread on the faucet to make the joint water-tight.

TOP WASHERS AND PACKINGS

A top washer or packing snugly fitting the stem is necessary to prevent leakage upward through the cap nut when a faucet is opened. If the space is too tightly packed, the stem binds, making it hard to operate the faucet; if too loosely packed, water spurts from the top of the cap nut. Figure 5 A shows a soft rubber and fabric top washer suitable for the compression faucet shown in Figure 1. This washer is one-eighth inch thick and rests on the top of the body of the faucet, making a water-tight joint when the cap nut is screwed down. Just below the soft washer and inside the top of the body a thin brass washer is placed to take the wear when the faucet is fully opened. These washers are separated in the illustration but are together when placed in a faucet.

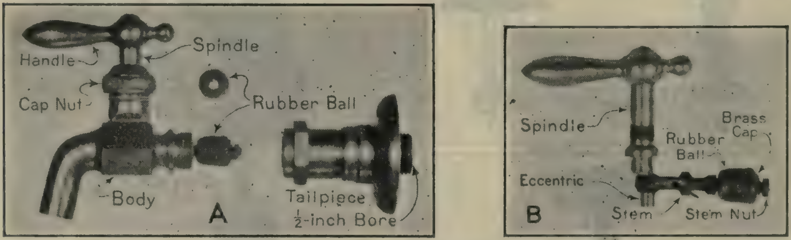

FIG. 4.—Fuller faucet: A, body unscrewed from tailpiece; B, spindle and stem removed from body

New faucets of the kind shown in Figure 1 usually have the top washers shown in Figure 5 B. The rubber washer fills the space beneath the cap nut, and the thin fiber and brass washers are for the purposes described above. If no top washer is available, the space may be packed with candle wicking or soft twine, to which a little mutton or beef tallow should be applied to lubricate the stem, to preserve the packing, and to make it more impervious to water.

When placing the top washer or washers on a compression faucet of the kind shown in Figure 1, it is unnecessary to shut off the water provided the faucet is closed. With the right hand keep the faucet closed and with a monkey wrench in the left hand unscrew the cap nut. Unscrew the handle screw and remove handle and cap nut. Put on new washers as shown in Figure 5 A or 5 B and reassemble the parts.

Figure 5 C shows the stem packing for the washstand faucet shown in Figure 2. The packing space is very small and is filled with candle wicking lubricated with tallow. There is a thin brass friction washer in the bottom of the stuffing box, and a hexagonal packing nut screws into the top of the box. To renew the candle

wicking, keep the faucet closed. Unscrew the packing nut with a monkey wrench, wrap a little wicking around the stem, and screw the packing nut down against the wicking and into the stuffing box.

Spindle packing for a Fuller faucet (see fig. 4) is shown in Figure 5 D and consists of three collars or rings obtainable from plumbing dealers for a few cents. A lead ring or packing about one-eighth inch long goes first (lowest) on the spindle; then a rubber and fabric composition packing about one-fourth inch long; then a brass packing about one-fourth inch long. Screwing down the cap nut compresses the composition packing, and the metal packings take up friction and wear. To put in new packings, shut off the water from the faucet and remove handle and cap nut as was described for compression faucets.

STOP AND WASTE COCKS

Figure 6 A shows an adjustable socket-lever handle, ground key, flat way, stop and waste cock to shut off water to part or all of a piping system and to drain the higher situated pipes from which the flow is cut off. A stop and waste should always be placed on the house supply pipe just inside the house or the cellar wall. They are very useful on branch pipes from a cellar or kitchen to upstairs or back rooms subject to freezing temperatures or other temporary discontinuance of the supply. Figure 6 B shows the disassembled parts, all excepting the handle being brass. The key or plug is ground to a water-tight fit in the body of the cock, and water is turned on or off by giving the handle a quarter turn. Turning the handle crosswise of the pipe shuts off the supply, and the dead water drains back through the small round hole in the side of the plug and out the waste tube.

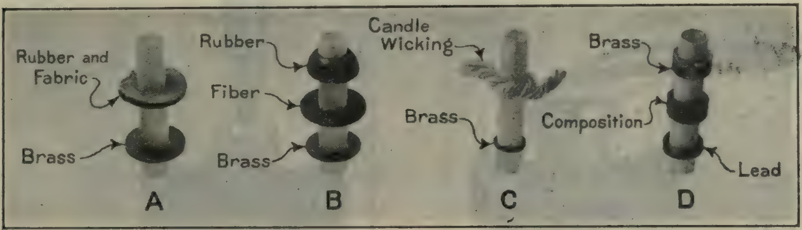

FIG. 5.—Top washers and packings: A, top washers commonly used in ordinary compression faucets (fig. 1); B, top washers which fill the space beneath the cap nut (fig. 1); C, candle wick packing and brass washer for washstand faucet (fig. 2); D, spindle packing for Fuller faucet (fig. 4)

Many stop and waste cocks have broken or bent handles or are otherwise rendered useless, because people do not understand them. As received from dealers, the nut on the bottom of the plug is generally screwed up tight, making it difficult or impossible to turn the handle and plug. Long periods of disuse frequently cause the plug to stick fast in the body. The plug is easily loosened by slightly unscrewing the bottom nut and striking the lower end of the plug a few light blows with a hammer. Slight leakage caused by wear of the plug or dirt around it may be prevented by cleaning the plug and tightening the bottom nut. A plug badly worn from long or continual use can be reground, but it is usually better and cheaper to get a new plug or a complete new cock.

BALL COCKS

Figure 7 A shows an ordinary, compound lever, ball cock to control the water supply in a flush tank. The float ball and the seat washer on the bottom of the plunger are the only parts likely to need repairs. The buoyancy of the float is the force which lowers the plunger, shutting off the water as the tank fills. A leaky, waterlogged float holds the plunger up, permitting constant flow and waste of water. A small leak in a copper float can be soldered. If a glass float is broken or a copper float is badly corroded, do not try to repair it. A new 5-inch copper float costs about 40 cents.

Figure 7 B shows the plunger and washer-holder cap which screws on the bottom of the plunger. The washer should be soft rubber or leather, because the force which holds it to its seat is not heavy. The cap is thin brass. To replace the washer, shut off the water and drain the tank. Unscrew the two thumbscrews which pivot the float-rod lever and plunger lever. Push the two levers to the left, drawing the plunger lever through the head of the plunger. Lift out the plunger, unscrew the cap on the bottom of the plunger, insert a soft, new washer, and reassemble the parts. The cap may be so corroded and weakened that it breaks during removal from the plunger. A new cap is then necessary, and it is well to have one or two on hand. When putting a washer on a ball cock, examine the seat to see that it is free of nicks and grit. The seat may need regrinding, as explained under compression faucets.

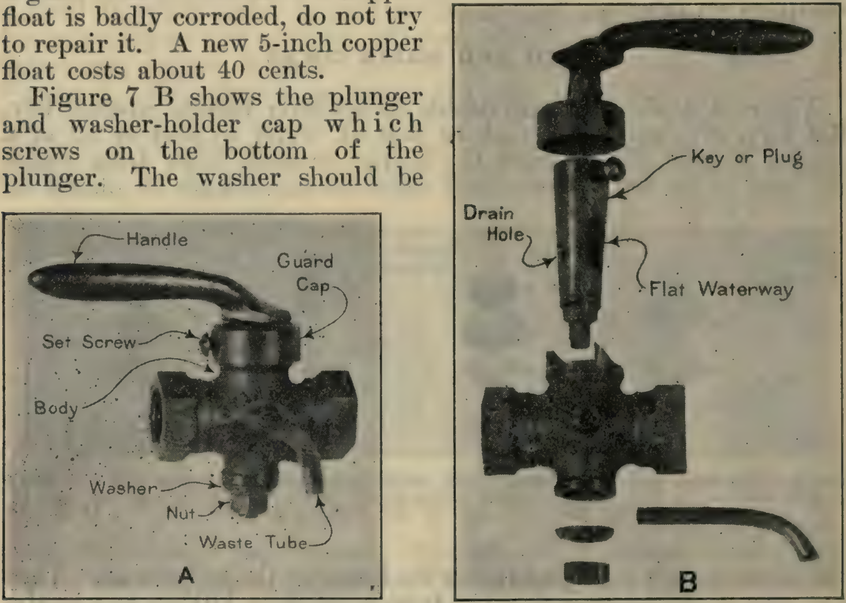

FIG. 6.—Stop and waste cock: A, parts assembled; B, parts unassembled

FLUSH VALVES FOR LOW TANKS

Figure 8 shows a common type of flush valve for a low tank. Probably no other plumbing in the home needs attention so often.

It is under water and subject to fouling and neglect. The hollow rubber ball gets out of shape and fails to drop squarely into the hollowed seat. The handle and lever fail to work smoothly or the lift wires get out of plumb, causing the ball to remain up when it should drop to its seat. To remove these difficulties, stop inflow to the tank by holding up the float of the ball cock or supporting it with a stick. Drain the tank by raising the rubber ball. If the ball is worn, out of shape, or has lost its elasticity, unscrew the lower lift wire from the ball and replace with a new one. A 2½-inch rubber ball costs about 25 cents, and a new one should always be kept in the home. The lift wires should be straight and plumb. The lower lift wire is readily centered over the center of the valve by means of the adjustable guide holder. By loosening the thumbscrew, the holder is raised, lowered, or rotated about the overflow tube. By loosening the lock nut and turning the guide screw, the horizontal position of the guide is fixed exactly over the center of the valve. These adjustments are very important. The upper lift wire should loop into the lever arm hole nearest to a vertical from the center of the valve. A tank should empty within 10 seconds. Owing to lengthening of the rubber ball and insufficient rise from its seat, the time may be longer than 10 seconds with a correspondingly weak flush. This trouble may be overcome by shortening the loop in the upper lift wire. A drop or two of lubricating oil on the lever mechanism makes it work more smoothly.

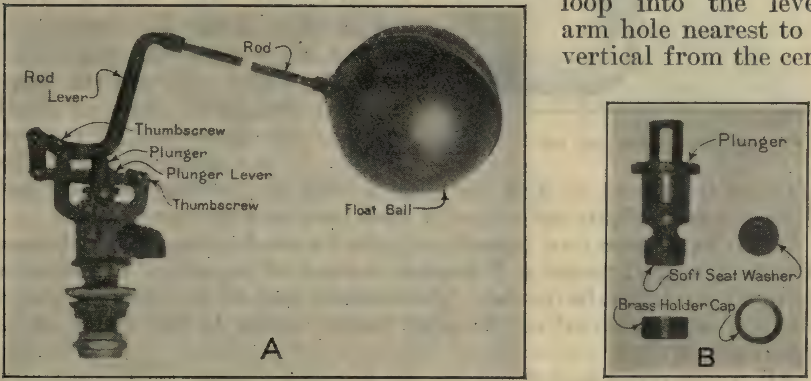

FIG. 7.—Ball cock: A, parts assembled; B, plunger, washer and cap

CLOGGED PIPES

Rust and dirt in water pipes are more or less successfully removed as follows: Tie a piece of small, stout cord to each end of a 2-foot length of small chain. Each piece of cord should be a little longer than the length of pipe to be cleaned. Attach the free end of one of the cords to a stiff steel wire and push the wire and cord through the pipe. By means of the cords pull the chain back and forth through the pipe, and then thoroughly flush the pipe with clean water under strong pressure. Long lines may be opened at intervals and cleaned section by section.

Other methods are: Use of a swab or wire brush attached to a small steel or brass rod, flushing with a powerful hand pump, or pouring in ordinary commercial muriatic acid, allowing time for the acid to act, and then flushing out the acid and dirt with clean water. The undiluted acid, acting for about an hour, may be used in lead pipe. A milder treatment is advisable for galvanized pipe, because zinc and iron are attacked by muriatic acid. However, a badly rusted pipe is unlikely to have much galvanizing left, and therefore the benefits of acid treatment should outweigh possible damage to the pipe. Although the action of muriatic acid on iron rust is slow, it is generally considered better to use a dilute solution of the acid for a short or moderate period of time, repeating the operation if necessary, rather than run the risk of damaging the pipe with a strong solution too long in contact. A mixture of 1 part of acid and 7 parts of water allowed to stand overnight in 1,000 feet of badly rusted 1-inch pipe has given good results. It is very important after the acid treatment to give the pipe a long and strong flushing with clear water to clean out the acid and loosened rust and dirt.

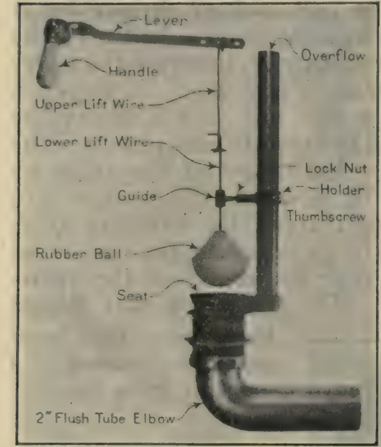

FIG. 8.—Flush valve for low tank

When putting in new pipe lines liable to need cleaning or to become frozen, it is well to use a T branch instead of an elbow wherever an abrupt turn must be made. The unused leg of the branch can be plugged, and removal of the plug makes access to the inside of the pipe easy.

All waste pipes and traps are subject to fouling. Dirt collects in the bottom and grease adheres to the sides. The usual way of clearing ordinary fixture traps is to unscrew the clean-out plug, as shown in Figure 9, and wash out the obstructing matter or pull it out with a wire bent to form a hook. Small obstructions are often forced down or drawn up by the use of a simple rubber force cup (sometimes called "the plumber's friend") costing 30 to 60 cents. This device is shown in Figure 10. The cup is placed over the fixture outlet and the fixture is partially filled with water. The wood handle of the cup is then worked rapidly down and up, causing alternate expulsion of the water from beneath the cup and suction upward through the waste pipe and trap. If a trap and the waste pipe from it are clogged with grease, hair, or lint, it is best to open or disconnect the trap and dig out the greasy matter with a stick. The use of chemical solvents in waste pipes is explained in Farmers' Bulletin 1426, "Farm Plumbing."

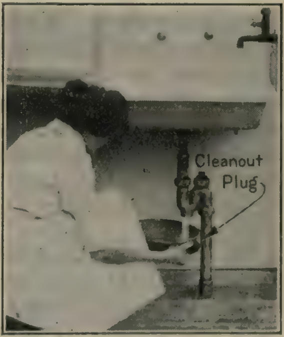

FIG. 9.—Cleaning out a sink trap

Small, coil spring-steel augers, of which two types are shown in Figure 11, are useful in dislodging or hooking obstructions in water-closets and other inaccessible traps and pipes. These augers are about one-half inch in diameter and come in lengths varying from 3 to 25 or more feet. The lower auger is about 8 feet long and has a crank at one end, and the other end is shaped like a dull corkscrew. It costs about $2 and is generally preferred to the upper auger for hard work in water-closets. The upper auger is about 4 feet long and is very useful for hooking rags and paper. By means of the handle and a small steel cable inside the coil the wire hooks can be pulled into the coil, thus facilitating entry into a trap.

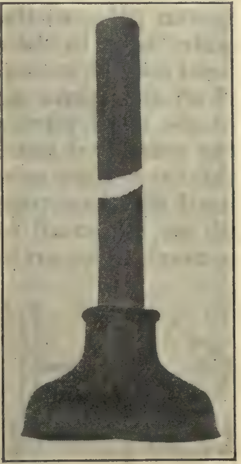

FIG. 10.—Rubber force cup

Two persons are generally needed to do effective work, one turning the crank and the other guiding the auger into the trap and helping to keep the coil free of folds and kinks. After using the auger, place a few sheets of crumpled toilet paper in the bowl and flush it to find out if the obstruction has been dislodged. The passageway through a water-closet is smaller than the connecting soil pipe. If the auger has forced the obstruction into the closet bend or the soil stack, there is usually no further trouble. Stoppages are generally due to improper use or carelessness. Newspapers, rags, matches, bottles, garbage, large pieces of soap, the tops of tin cans, and small toilet articles are the chief causes of trouble.

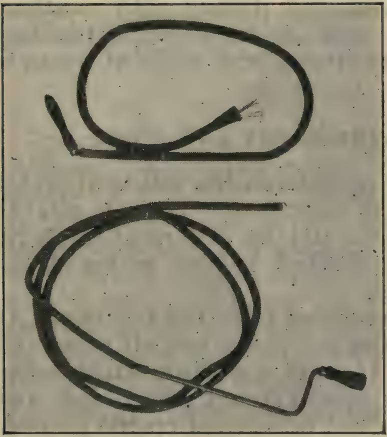

FIG. 11.—Coil spring steel augers

A coil spring cable one-fourth inch in diameter and 8 feet long with corkscrew ends and an adjustable handle for clamping at any point on the cable costs about $1.50. Its small size permits it to enter the waste openings of ordinary fixtures.

THAWING PIPES

The middle of a frozen pipe should never be thawed first, because expansion of the water confined by ice on both sides may burst the pipe. When thawing a water pipe, work toward the supply, opening a faucet to show when the flow starts. When thawing a waste or sewer pipe, work upward from the lower end to permit the water to drain away.

Applying boiling water or hot cloths to a frozen pipe is simple and effective. Where there is no danger of fire a torch or burning newspaper run back and forth along the frozen pipe gives quick results. Underground or otherwise inaccessible pipes may be thawed as follows: Open the frozen water pipe on the house end. Insert one end of a small pipe or tube. With the aid of a funnel at the other end of the small pipe pour boiling water into it and push it forward as the ice melts. A piece of rubber tubing may be used to connect the funnel to the thaw pipe. Hold the funnel higher than the frozen pipe, so that the hot water has head and forces the cooled water back to the opening, where it may be caught in a pail. The head may be increased and the funnel may be more conveniently used if an elbow and a piece of vertical pipe are added to the outer end of the thaw pipe, as shown in Figure 12. Add more thaw pipe at the outer end until a passage is made through the ice. Withdraw the thaw pipe quickly after the flow starts. Do not stop the flow until the thaw pipe is fully removed and the frozen pipe is cleared of ice. A small force pump is often used instead of a funnel and is much to be preferred for opening a long piece of pipe. If available, a jet of steam may be used instead of hot water; being hotter, it is more rapid.

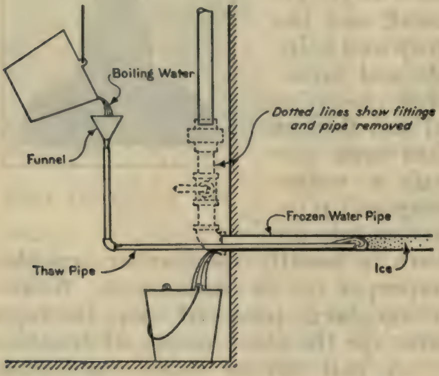

FIG. 12.—Thawing a frozen pipe

Frozen traps and waste pipes are sometimes thawed by pouring in caustic soda or lye, obtainable at grocery stores for about 25 cents per pound. Chemicals of this character should be labeled "Poison" and should be kept where children can not get them. To prevent freezing, the water in the traps of a vacant house should be removed during cold weather, and the traps should be filled with kerosene, crude glycerin, or a very strong brine made of common salt and water.

REMOVING SCALE FROM WATER BACKS AND COILS

Hard water causes a limy deposit or scale on the inside of water backs and heating coils. If allowed to accumulate the scale retards the circulation and heating of the water and, by closure of the bore, may prove dangerous. Moreover, continued neglect makes it increasingly difficult to remove the scale.

The water back or coil should be removed from the fire box. At the union or other joints nearest the fire box disconnect all pipes and unscrew them from the water back. If there is a clamp which holds the fire-brick lining against the oven, loosen it and remove side and end linings. Lift out the water back and take it out on the ground. Soft scale or sludge may be removed by pounding the water back with a mallet or hammer and then flushing with a strong jet of water. A long gouge or chisel is used on those surfaces that can be reached. Sometimes the water back is heated in a blacksmith's forge and then pounded, but unless carefully done this treatment may break it. Some householders keep a spare water back for use while the other is being cleaned.

Waters of varying chemical composition cause scale differing in composition and hardness. Ordinary limestone (calcium carbonate) scale, if not of excessive thickness, may readily be removed with muriatic acid. Gypsum (calcium sulfate) scale is hard and resistant and with other constituents in their more compact forms is little affected by muriatic acid. The water back should be laid on the ground and filled with a strong solution of the acid in water. The strength of the solution should vary with the amount of deposit, the ordinary mixture being 1 part of acid and 5 to 7 parts of water. If the deposit is very thick, the acid needs little dilution. Commercial muriatic acid in bottles containing 6 pounds (about 2½ quarts) costs 20 to 25 cents a pound. The bottle should be labeled "Muriatic acid—poison"; and, like the chemicals previously mentioned, it should be kept where children can not get it. Heating the water back hastens the action of the acid. At the end of an hour or two, or sooner if the deposit is dissolved, pour the solution from the water back and flush it thoroughly with hot water to remove the acid. If all the deposit has not been removed, repeat the operation, making sure that the acid is completely washed out before replacing the water back. In replacing the water back it is important to have it level, using a spirit level for this purpose.

Similar methods may be used with copper coils. Place the coil (or heater) on two sticks over a large bowl. With the aid of a lead funnel pour the acid solution down through the coil. Dip from the bowl and continue to circulate the solution through the coil until the deposit is dissolved. The coil should then be thoroughly washed out with hot water.

The hot-water flow pipe close to a water back or coil frequently becomes thickly covered with scale. If the pipe is brass, it may be disconnected and treated with acid and then washed out with hot water. If the pipe is galvanized iron and in bad condition, it will probably be more satisfactory to replace it with new pipe.

LEAKS IN PIPES AND TANKS

A small leak in a water pipe can be stopped in emergencies as follows: Place a flat rubber or leather gasket over the leak and hammer a stiff piece of metal, such as a picture hook, to fit over the gasket; secure both to the pipe with a vise or clamp obtainable at hardware or 5 and 10 cent stores. A small leak under low pressure is sometimes stopped by embedding the pipe in richly mixed Portland cement mortar or concrete. It is necessary to shut off the water from the pipe and build a boxing around it to hold the soft mortar closely against the pipe. Broken sewer pipe can be repaired in like manner. A wrapping of wire netting embedded in the mortar or concrete increases its tensile strength. A small hole in cast-iron pipe may be tapped for a screw plug.

Where a leaky screw joint can not be tightened with a pipe wrench, the leak is sometimes stopped with a blunt chisel or calking tool and hammer. Sometimes a crack or hole is cleaned out and then plugged and calked with lead, tinfoil, or a commercial iron cement mixed to the consistency of stiff putty. Sometimes a pipe band, a clamp with two bolts (similar but stronger than the one shown in fig. 14), or a split sleeve is employed to hold a thin coating of iron cement or a gasket over a leak. If the leak is at a screw joint, the band is usually coated inside with one-eighth inch of iron cement and then slipped over the pipe. Keeping the bolt farthest from the coupling or fitting a little tighter than the other, both bolts are tightened. During the tightening, the band should be driven with a hammer snugly against the coupling or fitting.

In addition to these methods and devices, there are several kinds of good, inexpensive, ready-made pipe and joint repairers obtainable of manufacturers and dealers.

A corroded and leaky spot in a steel tank or range boiler can be closed with an inexpensive repair bolt or plug obtainable from dealers. Figure 13 shows a homemade repairer consisting of a three-sixteenths by 3-inch toggle bolt costing 10 cents and a flat rubber gasket, brass washer, and nut. The link of the bolt, after being passed through the hole, takes an upright position, and screwing up the nut forces the gasket tightly against the outside of the boiler.

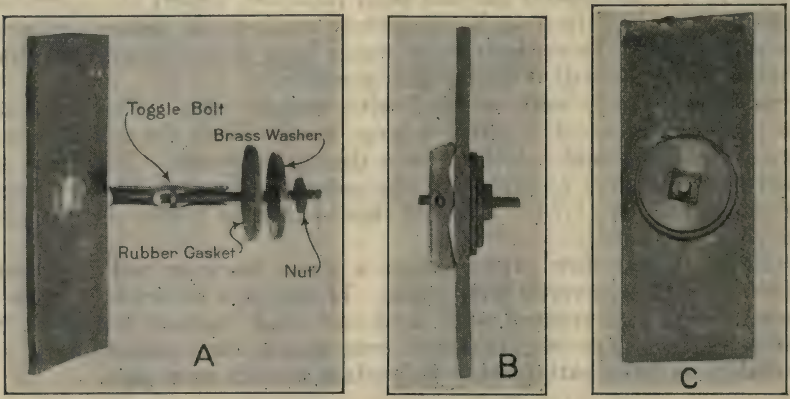

FIG. 13.—Homemade tank repairer: A, passing the link of the toggle bolt through the hole (enlarged) in the tank; B. side view of edge of tank with bolt, washers, and nut after being tightened; C, outside view of completed job

A small hole must be reamed or enlarged with a round file to a diameter of about five-eighths inch. The metal beneath the gasket should be firm and clean. A little candle wick packing may be wrapped around the bolt to prevent leakage along the bolt. Sometimes a hole is closed by driving in a tapered steel pin to turn the metal inward, forming a surface which can be tapped for an ordinary screw plug. A hole in the wall of a tank or pipe having considerable thickness can be easily and quickly closed by screwing in a tapered steel tap-plug which cuts and threads its way through the wall. These plugs in different sizes are obtainable of dealers and a monkey wrench is the only tool required to insert them; it is unnecessary to shut off or drain the water from the tank or pipe.

A small leak at a seam or rivet can often be closed by merely rubbing a cold chisel along the beveled edge of the joint. Do not attempt to calk a seam unless the plates have considerable thickness and the rivets are closely spaced and are close to the calking edge, and then use extreme caution. Run a regular calking tool or blunt chisel along the beveled edge, tapping the tool very lightly with a light hammer to force the edge of the upper plate against and into the lower plate.

CRACKED LAUNDRY TUBS

Cracks in slate, soapstone, or cement laundry tubs are made watertight with a mixture of litharge and glycerin or a specially prepared commercial cement. The litharge and glycerin are mixed and stirred to form a smooth heavy paste free from lumps. The crack should be cleaned out to remove all grease and dirt and the paste should be worked into the crack with a case knife. A paste of Portland cement and water, or of the white of an egg and fresh lump lime, has been used successfully for this purpose.

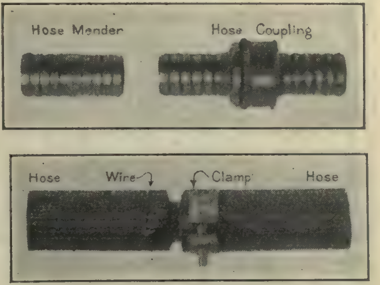

FIG. 14.—Hose menders: Above, hose mender and hose coupling; below, two pieces of hose joined with a mender. The left-hand piece is fastened with wire twisted with a pair of pliers, and the right-hand piece is clamped

HOSE MENDERS OR SPLICERS

A break in garden hose can be quickly repaired or two pieces of hose can be joined with a 10 or 15 cent iron or brass hose mender or splicer shown in Figure 14 (upper left). Cut off the defective piece of hose, insert the mender in the good ends of the hose, and wire or clamp the hose as shown in Figure 14 (below). Menders come to slip inside of one-half, three-fourths, or 1 inch hose. A regular brass hose coupling shown in Figure 14 (upper right) and costing 25 to 40 cents can be used for this purpose.

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September 3, 1925

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1461

THE COMMON CABBAGE WORM AND ITS CONTROL

THE COMMON CABBAGE WORM is the best known and most important of the many insect enemies of cabbage and related crops. It feeds upon the cabbage leaves and eats into the "buds" and heads. If not restrained by natural or artificial means it would frequently cause the total destruction of the crops which it attacks, since it multiplies rapidly and produces, even in the North, three broods or generations a year.

It is a velvety green worm, or caterpillar, measuring when full grown about 1¼ inches in length, and is the larva, or young, of a white butterfly, well known to most farmers. It is found not only throughout the United States but almost all over the world. It begins work very early in the season and continues active until frost.

Natural enemies contribute very largely to the control of this pest, and in some seasons prevent its injuries from becoming serious. Wherever it occurs, however, it should be combated as soon as observed, and continuously as far as may be necessary. The best method of control lies in the use of common arsenic poisons—lead arsenate, calcium arsenate, or Paris green.

This bulletin is a revision of, and supersedes, Farmers' Bulletin 766, The Common Cabbage Worm.

Washington, D. C. May, 1926

THE COMMON CABBAGE WORM[1] AND ITS CONTROL

By F. H. Chittenden

Entomologist, Truck-Crop Insect Investigations, Bureau of Entomology

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INTRODUCTORY

THE MOST DESTRUCTIVE among the many insect and other enemies of cabbage and related crops is the larva, or caterpillar, of the common cabbage butterfly (figs. 1, 2). This caterpillar, the common cabbage worm, is well known to farmers throughout this country (and in the Old World as well), and the butterfly is generally recognized by the farmer as the parent of the "worms."

The common cabbage butterfly was introduced from Europe and was first recognized at Quebec, Canada, in 1860. In 1865 its first appearance in the United States was noted in Maine; in the following year in northern New Hampshire and Vermont. In 1868 it had reached New York and soon thereafter began to attract attention in other localities. In 1875 it appeared in Cleveland, Ohio, and two years later in Illinois. In 1880 it had penetrated southward to the Gulf States. The species has spread until now it is known in practically every State in the Union. It appears to favor no particular part of the country, being as destructive in the Gulf region as in Canada and New England.

DESCRIPTION

This cabbage worm is velvety green, or of about the same color as the cabbage on which it feeds. There is a faint yellow stripe down the middle of the back and a row of yellow spots along each side in line with the breathing pores. The surface of the body, viewed through a hand lens, is seen to be somewhat rough and finely dotted with small black spots. It measures, when full grown, about 1¼ inches in length. (Fig. 1, *c*.) It differs mainly from the cabbage looper,[2] another caterpillar commonly found on such crops, in having five pairs of prolegs or prop legs (unjointed hind legs) instead of four. The cabbage looper, because of the limited number of its prop legs, "loops" in walking, like a measuring worm.

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[1] *Pieris rapae* L.; order Lepidoptera, family Pieridae.

The butterfly has a wing expanse of nearly 2 inches. It is white, marked with black near the tops of the forewings. The female (fig. 1, *a*) has two conspicuous black spots on each forewing, whereas the male (fig. 2) has only one. The under side of the hind-wing is of a uniform straw-yellow color of satiny appearance, and in both sexes there is usually an indistinct black spot near its tip. The body of the female is whitish; that of the male is usually darker on the back. The male is usually smaller than the female.

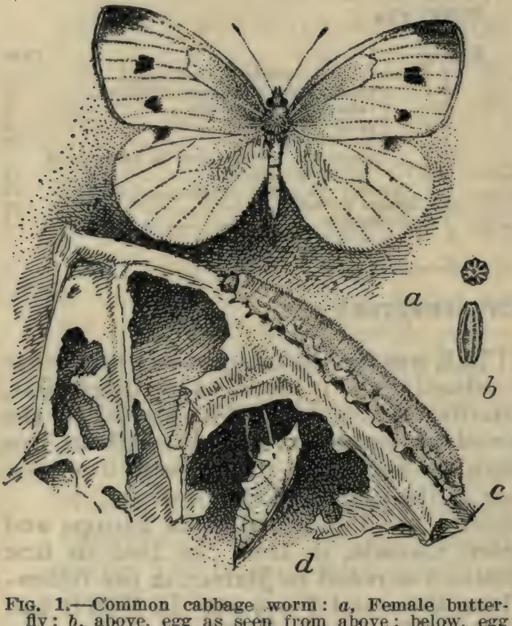

FIG. 1.—Common cabbage worm: *a*, Female butterfly; *b*, above, egg as seen from above; below, egg as seen from side; *c*, larva, or "worm," in natural position on cabbage leaf; *d*, suspended chrysalis; *a, c, d*, slightly enlarged; *b*, more enlarged

The eggs are spindle-shaped, of a pale yellowish color, strongly ribbed (fig. 1, *b*), and large enough to be seen readily with the unaided eye. They are laid by the butterfly singly, on end, and usually on the under side of the outer leaves of cabbage and other food plants.

When the caterpillar, or "worm," becomes full grown it attaches itself to a cabbage leaf or other near-by object by means of a threadlike girdle of silk, and is soon changed to a chrysalis, an inactive stage. (Fig. 1, *d*.) The chrysalis is a little less than three-fourths of an inch long, varying in color through dirty gray to yellow, green, and dark gray.

FOOD HABITS

The common cabbage worm feeds on all forms of cruciferous plants, being particularly fond of cabbage and cauliflower and less destructive to turnip, kale, collards, radish, mustard, and horse-radish.

The butterflies sip the nectar of flowers of various kinds and are commonly seen hovering over them. They are especially fond of the white blossoms of crucifers, and of white aster, lavender, heliotrope, and thistle. Like other butterflies, this species is active by day, being on the wing from early morning until near dusk. It is a comparatively slow but tireless flyer, capable of journeying long distances.

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[2] *Autographa brassicae* Riley.

LIFE HISTORY

The butterflies appear on warm, sunny days as early as March, even in the Northern States, and thereafter may be seen flying until after several severe frosts in October. In the Gulf region they occur throughout the season. Pairing and egg laying begin within a day or two after the adult comes out of the chrysalis.

The different stages naturally vary in duration, depending on temperature conditions, the egg stage lasting from four to eight days.

The caterpillar, which hatches from the egg, eats greedily and grows rapidly, reaching maturity in from 10 to 14 days after hatching. It molts four times; there are therefore five distinct stages of growth, the first molt taking place, in the warmest weather, in about 2 days from the time of hatching, the second stage lasting from 2 to 3 days, the third and fourth from 1 to 2 days each, and the fifth from 4 to 5 days. In the summer time the chrysalis period lasts from 7 to 12 days. In the more northerly States the insect passes the winter as a chrysalis, and the butterflies appear the following spring.

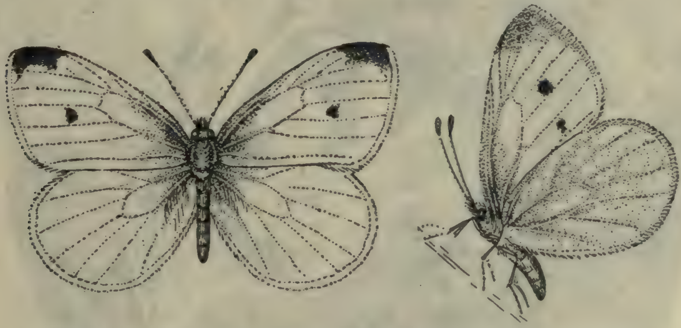

FIG. 2.—Common cabbage butterfly: Male, wings spread at left, wings folded at right. Somewhat enlarged

The period of development (egg to butterfly) covers between 22 and 42 days. In New England and Wisconsin this species is credited with producing three generations in a season, and five or six are reported for North Carolina.

NATURE OF INJURY

This cabbage worm has been rightly termed the bane of the cabbage grower and the dread of the housewife. It begins work early in the season, damaging young plants. After riddling the outer leaves it attacks the tender inner leaves as they form, frequently feeding within the immature heads and rendering the cabbage unfit for food because of the abundant dark-green excrement which it deposits. Before cooking it is frequently necessary to tear the head apart to insure that no disgusting worms are concealed within. In cool weather the caterpillar often feeds freely exposed on the surface of the leaves in the sunshine.

Frequently the worm works into the center of the cabbage, attacking the undeveloped "heart" and rendering the head worthless for market. (See fig. 3.) Seedling cabbage grown in cold frames is often damaged shortly after it is set in the field, the worm cutting out the "bud," and thus destroying the future head. Injury of this nature may be very serious, many plants being a complete loss. Somewhat unusually the worms occur in such numbers as to congregate on a single leaf and devour it in a very short time. (See fig. 4.)

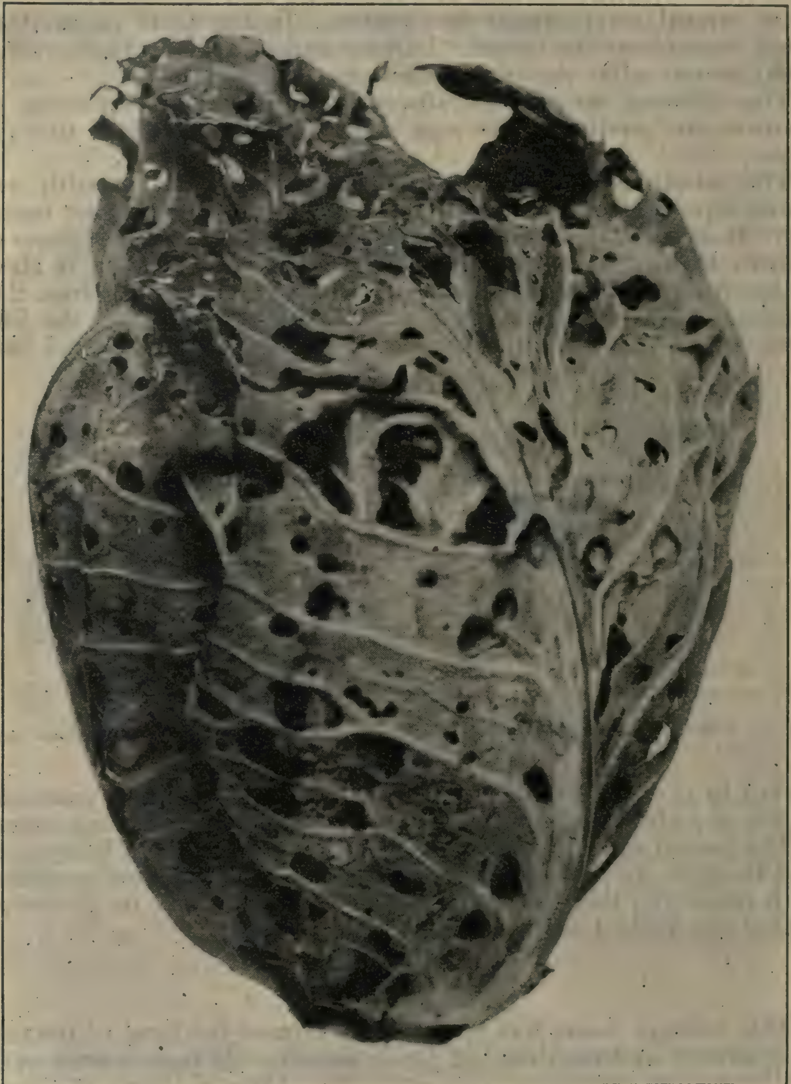

FIG. 3.—Immature cabbage head, showing injury by worms feeding within. Reduced one-half

NATURAL ENEMIES

Were it not for certain natural checks this insect would be a still greater pest. The most important of its insect enemies are small wasplike parasites, or four-winged flies, the immature forms of which feed within the body of the cabbage worm. All are introductions from Europe. One of the most efficient of these, the cabbage-worm ichneumon fly[3] (figs. 5, 6), was purposely imported in 1883 from England as a means of controlling this cabbage worm, and has more than justified its introduction. During the fall of 1904 this parasite held its host under complete control at Washington, D. C., killing every worm which came under the writer's observation. The cabbage-worm chalcis fly[4] (fig. 7) bears the same relation to the cabbage worm as does the ichneumon fly, and is therefore beneficial, especially in the Northern States. As it was first noted in this country in 1869, it was evidently imported with its host. The eggs of this chalcis fly are deposited in the cabbage worm, hatch into larvæ, and live within it, and the adult parasites which develop from them come out from the chrysalis stage of the worm.

Large wasps, particularly certain paper wasps[5] and related forms, are also of great service in reducing the numbers of this and other cabbage worms, appearing to prefer them to other prey.

The small, evil-smelling ambush bug[6] hides in flowers, such as the thistle and goldenrod, and destroys numbers of butterflies, capturing them and sucking out their body fluids.

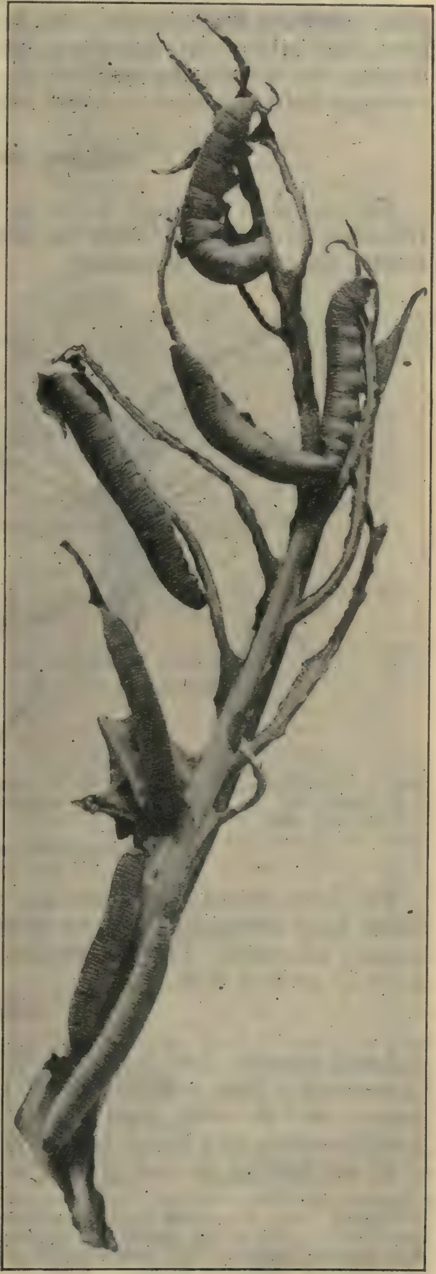

FIG. 4.—Remains of cabbage leaf eaten by seven common cabbage worms. Slightly enlarged

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[3] *Apanteles glomeratus* L.

[4] *Pteromalus puparum* L.

[5] *Polistes metricus* Say, *P. pallipes* Lepel., and others.

[6] *Phymata wolffi* Stål.

Numerous other insect enemies[7] attack this cabbage worm, and it is sometimes subject to a contagious bacterial disease[8] similar to that of the cabbage looper. It is not especially susceptible to this malady, although in some seasons great numbers are destroyed by it.

Birds which are known to feed upon cabbage worms are the chipping sparrow, English sparrow, and house wren. It is certain, however, that other birds eat them, and in one case it was reported that during the winter the number of chrysalids (resting stage) of the cabbage butterfly were reduced more than 90 per cent by birds.

CONTROL ON CABBAGE

The common cabbage worm is not difficult to control if proper remedies are used as soon as damage is detected and before the worms become too abundant.

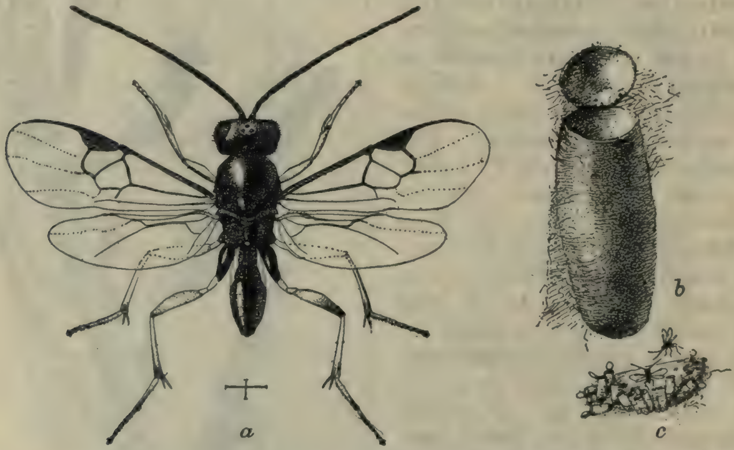

FIG. 5.—Cabbage-worm ichneumon fly, a valuable parasite of the common cabbage worm: *a*, Adult fly; *b*, cocoon; *c*, flies escaping from cocoons. *a*, *b*, highly magnified; *c*, natural size

ARSENICALS OR ARSENIC POISONS

The best remedy is poisoning with some form of arsenical; of these lead arsenate, calcium arsenate, and Paris green are about equally effective. The poison may be applied to the plants either as a spray or as a dust.

SPRAYS

Lead arsenate has largely taken the place of Paris green as an insecticide. It is less harmful to growing plants, sticks better to the leaves, and in water does not settle as quickly as does Paris green. Lead arsenate as a spray is also valuable in that it leaves, on drying, a white coating on the plants, so that after spraying it is easy to see which plants have been treated and how thorough the treatment has been. The spray should be mixed as follows:

---

[7] Among other predacious enemies observed in this country are the wheel bug (*Arilus cristatus* L.), the armed soldier-bug (*Podisus maculiventris* Say), the parasitic tachina flies *Exorista vulgaris* Fall. and *Frontina archippivora* Will., and a flesh fly, *Sarcophaga* (*Boettcheria*) *latisterna* Parker. About 10 additional parasites are listed in Europe.

[8] *Micrococcus pieridis* Burrill.

Lead arsenate (powder)	2 pounds	or	½ pound.
Soap	2 pounds		½ pound.
Water or Bordeaux mixture	50 gallons		12½ gallons.

Calcium arsenate has a higher arsenic content than lead arsenate and therefore possesses greater killing power. Its adhesiveness is about the same as that of lead arsenate. The spray should be mixed as follows:

Calcium arsenate (powder)	1½ pounds	or	6 ounces.
Soap	2 pounds		8 ounces.
Water or Bordeaux mixture	50 gallons		12½ gallons.

For small amounts of sprays use 10 level teaspoonfuls of the arsenical to 1 gallon of water and about 1¼ ounces of soap.

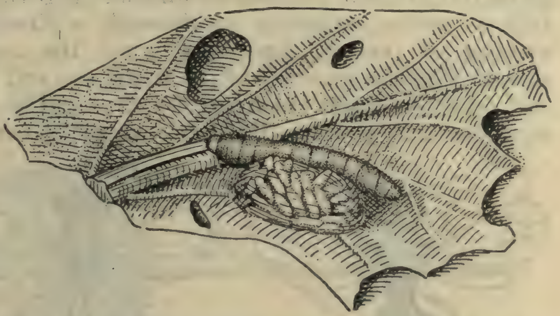

Fig. 6.—Parasitized cabbage worm, showing cocoon mass of cabbage-worm ichneumon fly below

Paris green was one of the first poisons used for the control of leaf-feeding insects. The objections to its use are that it is likely to injure foliage, it does not remain mixed with water for any length of time, and does not stick well to leaves such as those of cabbage and cauliflower. The spray should be mixed in the following proportions:

Paris green	1 pound	or	4 ounces.
Soap	2 pounds		8 ounces.
Water or Bordeaux mixture	50 gallons		12½ gallons.

The sticking and spreading qualities of these spray materials are improved by the addition of soap, which is particularly valuable in sprays to be used on such types of leaves as those of cabbage. Effective treatment requires about 150 gallons of spray to the acre for one application. When applied with a hand sprayer about 1 gallon of the spray to 50 feet of row will be required.

DUSTS

Arsenic poisons may be applied in dust form by mixing the poison with a cheap carrier, such as hydrated or air-slaked lime, land plaster, dusting sulphur, or other cheap, light, finely pulverized material, which will adhere to the cabbage leaves.

Dusts are more easily and quickly applied than sprays, but do not always distribute the poison so evenly. Unless applied when the foliage is wet, the dust does not stick so well as does a spray mixture.

The following mixtures are recommended:

Lead arsenate	1 pound.
Hydrated lime	5 pounds.
Or	
Calcium arsenate	1 pound.
Hydrated lime	5 pounds.
Or	
Paris green	1 pound.
Hydrated lime	15 pounds.

The dusts should be applied at the rate of about 30 to 40 pounds to the acre.

PREPARATION OF SPRAY MIXTURES

When preparing the spray mixtures in quantities, such as from 25 to 100 gallons, proceed as follows: Fill the spray tank about half full of water, running it through a fine strainer. The proper amount of poison, depending upon the capacity of the sprayer, should then be mixed with a small amount of water in a 3-gallon pail or other small container by thoroughly stirring the mixture so as to wet and separate the particles of poison. Then pour this concentrated mixture through a strainer into the spray tank and add the full amount of water to the sprayer. The soap should be dissolved in small quantities of hot water before it is added to the spray. It is good practice to prepare the soap solution some time before spraying is to begin, so that the time consumed in dissolving the soap will not cause any unnecessary delay in the spray work.

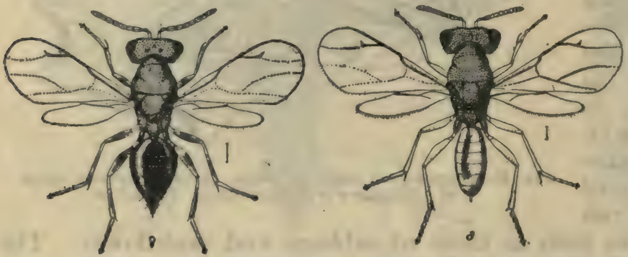

FIG. 7.—Cabbage-worm chalcis fly, a useful parasite of the common cabbage worm. Female at left, male at right. Size shown by hair line at right

In preparing small quantities of spray mixtures the poison should be first mixed with a little water and thoroughly stirred before the full amount of water is added. Unless the spray is kept fairly well agitated or stirred, the poison will separate from the water and settle to the bottom of the tank. It is therefore necessary, in order to keep the spray mixture uniform, that the sprayer be equipped with a good agitator or some means be taken to stir the spray mixture from time to time. In the case of hand compressed-air sprayers, these can be shaken vigorously at intervals and a wooden paddle can be used to keep the spray mixture stirred in bucket pumps not equipped with agitators.

PREPARATION OF DUSTS

In the preparation of poisoned dust mixtures the principal object is to mix the poison thoroughly with the material which is used to dilute the poison, such as hydrated lime, land plaster, etc. A satisfactory mixture can be prepared in 50 to 100 pound lots by placing the materials in a steel drum or barrel which can be tightly closed and then rolling the drum for a distance of 400 to 500 feet. At intervals of about 50 feet the drum should be turned end over end a few times. Another method, which can be employed when a steel drum is not available, is to mix the dust in a flat box with a garden hoe. The lime or other substance which is to be used to dilute the poison should be spread out in a thin layer over the bottom of the box and about one-fourth of the poison should be evenly distributed over this layer and the two materials mixed thoroughly with the hoe. The dust should then be drawn up in a pile to the center of the box, care being exercised to remove it from the corners. This mixture should then be spread out in a thin layer, another fourth of the poison added, and the mixing process repeated. This procedure should be continued until all the poison is mixed with the material which is used to dilute it. Any poison mixtures which remain unused after dusting operations should be plainly marked "Poison" and stored until needed.

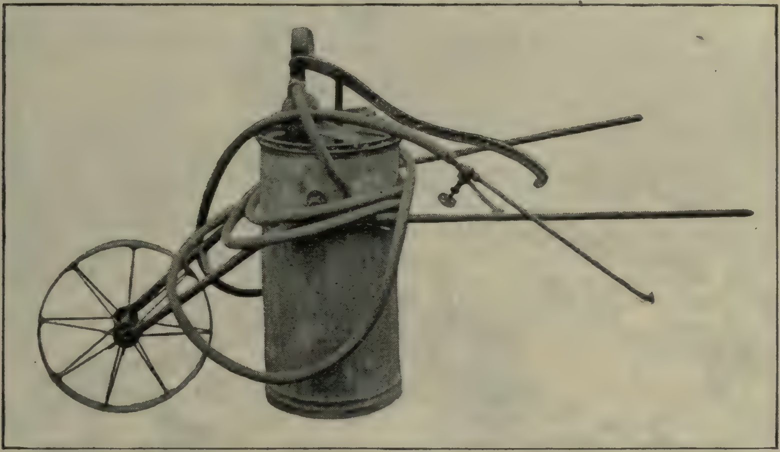

FIG. 8.—Wheelbarrow type of sprayer; effective for moderate-sized areas

SPRAY EQUIPMENT

For the application of sprays, machines that will develop a high pressure are the most satisfactory. Where large acreages are to be treated, the arsenicals may be applied by power or traction sprayers. In power sprayers the pump is usually operated by a gas engine, and in traction sprayers the pump is operated from a wheel of the spray cart. The spray should be applied to each row of plants by three nozzles, one directed downward and one to each side of the row.

For smaller plantings a barrel or wheelbarrow type of sprayer will be found satisfactory. (See fig. 8.) In small garden patches a hand sprayer of the compressed-air type (fig. 9) does effective work.

The nozzles used should be of the type which delivers a cone-shaped spray. Under pressure this type of nozzle gives a fine, mist-like spray, very desirable for effective results.

DUSTERS

Power or traction dusters (fig. 10) are most useful for large plantings. Hand dusters (fig. 11) may be used with success on one or two acres.

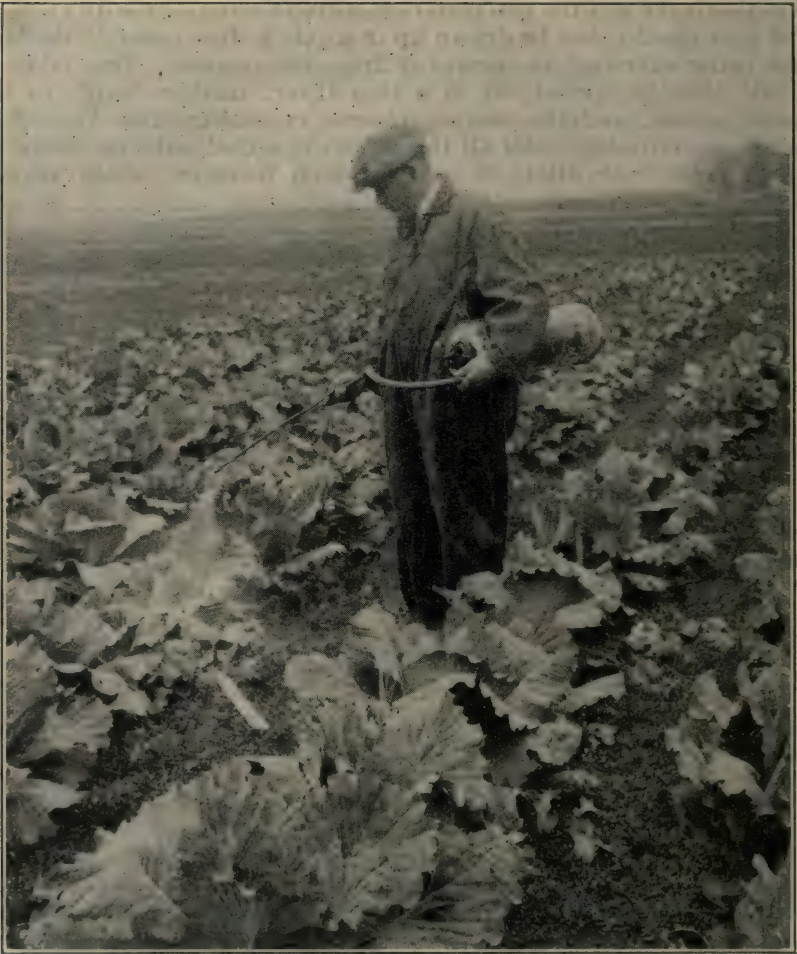

FIG. 9.—Compressed-air sprayer in operation. Note method of carrying. Right hand controls outlet valve

Dust may be applied to garden plantings by means of a cheese-cloth sack (fig. 12) shaken over the plant, or by means of a tin can with holes punched in the bottom of it the size of a 10-penny nail, and a stick for a handle attached to its side. The dust is applied by shaking the can over the plant. Treatment by these methods is

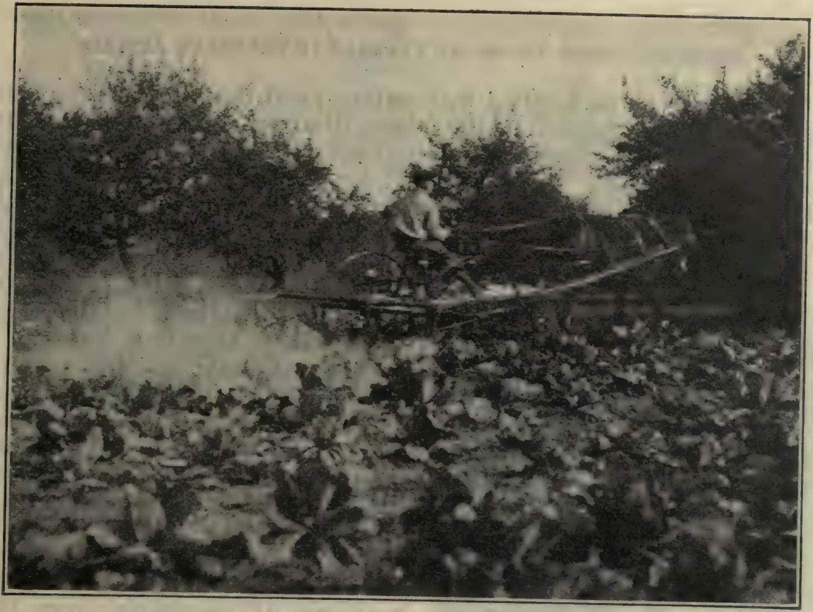

FIG. 10.—Traction type of duster in operation in cabbage field

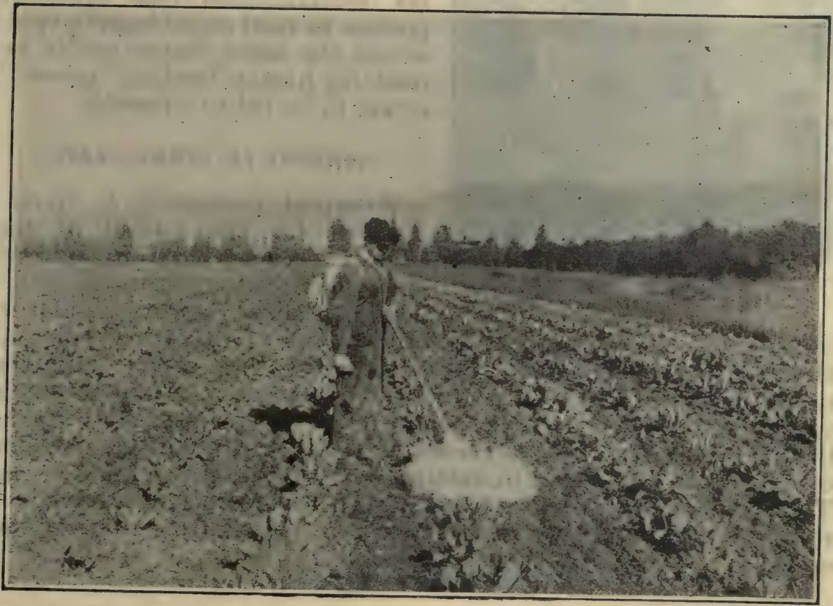

FIG. 11.—Dusting cabbage field. Note cloud of dust completely covering all parts of plants

not so effective as that obtained by the use of machinery made for dusting purposes.

ARSENICALS SAFE TO USE ON CABBAGE IF PROPERLY APPLIED

Arsenicals can be applied with safety until the heads of the cabbages are nearly formed, as the poison disappears almost completely within two or three weeks after application, and even earlier if there are frequent rains. Arsenic should not be applied just before the cabbage is cut or if the worms have tunnelled into the mature head. After the removal of the outer leaves, in preparing cabbage for market, and after other useless leaves have been picked off, as is done before the cabbage is cooked or prepared for salad, usually very little, if any, arsenic is left.

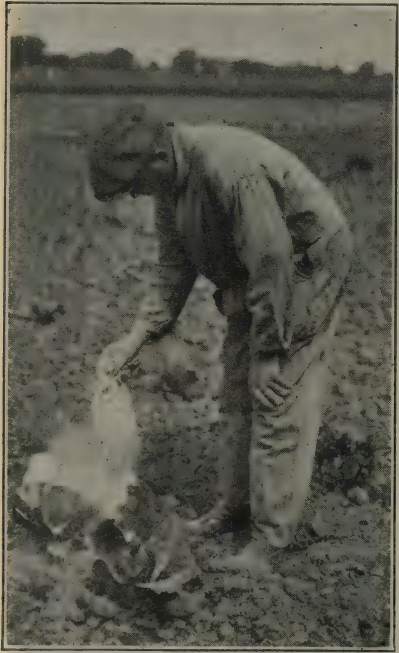

FIG. 12.—Dusting cabbage with cheesecloth bag

Chemical analysis has shown that a week after cabbage had been sprayed with an arsenic poison as prescribed in this bulletin, and prepared for cooking in the usual manner—that is, by removing all loose outer leaves—not a trace of arsenic remained. The writer knows of no authentic recorded instances of poisoning from the consumption of cabbage treated with an arsenical poison. It is not recommended that arsenical poisons be used on cabbage in cases where the outer leaves are to be used for human food as "greens," or are to be fed to livestock.

CONTROL ON OTHER CROPS

Arsenical treatment, as recommended for the control of the worm on cabbage, can be employed to protect seedling crops of cauliflower, Brussels sprouts, collards, turnips, kale, and mustard. In the treatment of cauliflower and Brussels sprouts arsenicals can be applied with safety until the edible heads of the cauliflower or the "sprouts" of the Brussels sprouts appear, but after this period in the development of the plant the use of arsenical poisons *should be avoided*, as the edible portions of the plant are likely to retain some of the poison at harvest. Turnips, kale, and similar plants which bear edible foliage should receive applications of the poison only in the seedling stage of the crop.

CLEAN FARMING

If by any possibility cooperation in clean methods of farming and in the use of arsenicals could be obtained, much of the loss due to the cabbage worms might be averted. The practice of leaving cabbage stalks and heads and remnants unfit for market in the field after the main crop has been harvested should be avoided. All remnants should be disked or plowed under.

SUMMARY

The common cabbage worm is a velvety green caterpillar, about 1¼ inches long when full grown. It is the larva or young of a white butterfly. It begins work on young plants soon after they are set out, and will, if unmolested, riddle the outer leaves and eat into the "buds" and heads. As a result of its activities entire crops are sometimes seriously damaged.

It is a serious menace to the cultivation of cabbage, cauliflower, turnip, and related crops, and the farmer must be prepared to combat it during their growth. In the warmest weather it can develop from egg to adult, or butterfly, in a minimum of 22 days. Even in its northernmost range it develops three generations, or broods, annually, and southward there may be as many as six distinct generations.

Natural enemies contribute largely to the control of this insect. Without them it would be still more destructive. It is necessary, however, to resort to insecticides for satisfactory control, the most useful being lead arsenate, calcium arsenate, and Paris green, applied either as sprays or dusts. The method of application can be varied according to the area to be treated. If properly applied arsenical poisons can be safely used for this purpose.

Cooperation in clean methods of farming, if it could be brought about, would do much to avert the ravages of the cabbage worm.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

December 30, 1925

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1462

THE POTATO LEAFHOPPER AND HOW TO CONTROL IT

THE POTATO LEAFHOPPER is a very small green insect which often occurs in vast numbers. It is a serious and costly enemy of potatoes, beans, and other crops in the North-Central and Northeastern States.

It injures potatoes by feeding on the foliage, and causes a diseased condition called hopperburn, which, under conditions favorable to its spread, may ruin an entire crop in one or two weeks.

This leafhopper can be controlled and the hopperburn held in check by the proper and timely application of Bordeaux mixture. Yields are greatly increased when this spray is used.

This bulletin has been prepared to acquaint the grower with the insect, the nature of its injury to vegetable crops, and the proper measures for its control. It is a revision of and supersedes Farmers' Bulletin 1225, The Potato Leafhopper and Its Control.

Washington, D. C. May, 1926

THE POTATO LEAFHOPPER AND HOW TO CONTROL IT

By J. E. Dudley, Jr., *Entomologist, Truck-Crop Insect Investigations, Bureau of Entomology*

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THE POTATO LEAFHOPPER[1] is one of the most important insect enemies of the potato in the United States. Serious outbreaks have occurred periodically in certain sections since the early eighties, and about 1896 this insect became known as a menace to the potato crop in the Middle and Eastern States. This leafhopper attacks a large variety of plants and may at times become injurious on several of them.

The feeding injury, although severe, is not nearly so serious as the diseased condition called "hopperburn," which appears on the plants on which the leafhopper feeds.

It is necessary to recognize this leafhopper in order to be prepared to control it and to prevent the loss of large acreages of potatoes from hopperburn.

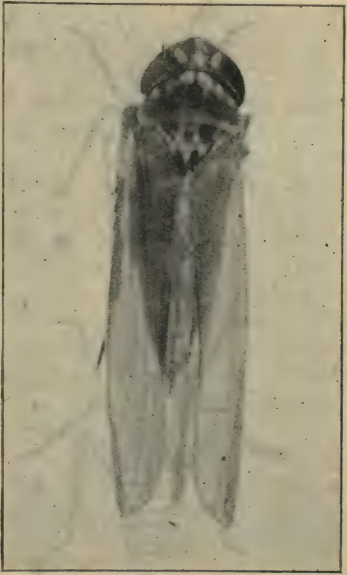

FIG. 1.—Adult potato leafhopper. Greatly enlarged

DESCRIPTION

The adult or full-grown leafhopper (fig. 1 and fig. 2, G) is a very small, pale-green insect, about one-eighth of an inch long, with prominent white markings. It has a more or less distinct H on its body between the head and base of the wings. There

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[1] *Empoasca mali* LeB., order Hemiptera, family Cicadellidae.

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are six roundish white spots above this **H** and three white, wedge-shaped spots below it. Adults fly and hop readily when disturbed.

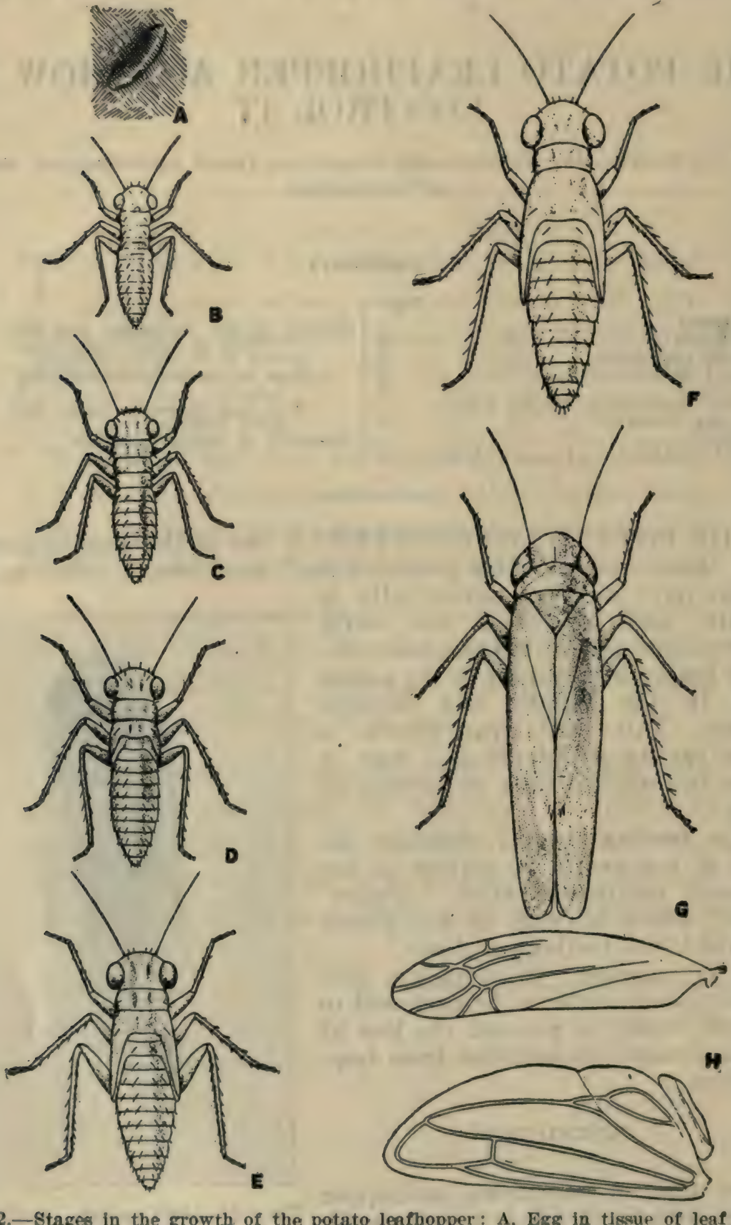

FIG. 2.—Stages in the growth of the potato leafhopper: A, Egg in tissue of leaf; B–F, stages of young leafhopper or nymph; G, adult leafhopper; H, fore and hind wings of adult leafhopper

The eggs (fig. 2, A) are tiny and transparent. They are laid in the tissue of the potato leaf and are invisible from the outside, but after they hatch the leaf tissue dies and forms small, sunken pits marking the previous location of the eggs.

The nymphs (fig. 2, B to F), or young leafhoppers, pass through five stages of growth and shed their skins each time, developing wings in the adult stage. When newly hatched, the nymphs are very small and nearly white, but slowly turn green as they grow. When the insect is nearly mature, the partially developed wings may be seen on each side of the body. At this stage the nymph is very active, being able to hop from leaf to leaf.

DISTRIBUTION

The potato leafhopper occurs in practically every State of the Union, in parts of Canada and Mexico, and in South America. Its greatest damage to potatoes has occurred in the Northern and Central States, roughly from Montana to New York, and south to Ohio, Illinois, and Kansas.

ECONOMIC IMPORTANCE

The economic loss to the potato grower caused by the attack of the potato leafhopper and the accompanying hopperburn is probably greater than that caused by any other potato insect. The loss caused by its attack on certain other crops, notably beans, is considerable. As the insect appears in injurious numbers periodically and as injury caused by it may spread very rapidly under favorable weather conditions, it is essential that the grower be equipped and ready to cope with an outbreak before it has threatened his crop.

SEASONAL HISTORY

The potato leafhopper lives over the winter in the adult stage, hidden away in brush heaps, matted dead vegetation such as weeds, and other protected places. From May 1 to 15, according to the season, leafhoppers emerge from their winter quarters, feed for a week or so on various trees and shrubs, then migrate suddenly to potatoes and beans, where mating and egg laying begin. This definite migration usually takes place the first week in June. Adults of the first generation, appearing the last of July and the beginning of August, migrate to some extent from early to late potatoes. The time and extent of this migration are determined by the temperature and the condition of the vines upon which they have bred. In this way late-planted potatoes become infested. There are two generations of the insect each year in the Northern States.

Under conditions in Wisconsin the adults which have lived through the winter die off in July and their young mature about the last of July, forming the first generation. Thus it takes approximately one month from the time the eggs are laid until the adult leafhoppers appear. A second generation is now produced, although in a slightly longer time, and the new adults begin to appear early in September. These adults live through the winter and do not lay eggs until the next spring.

HOPPERBURN

Adults and nymphs of the potato leafhopper suck the juices or sap of plants by means of their delicate beaks, which they insert into the leaves. The injury thus caused through loss of plant juices must of itself be considerable when a large number of leafhoppers are present.

In addition to the injury caused by loss of plant juices, however, this leafhopper is the cause of a distinct injury called "hopperburn," which follows its feeding on potato and many other plants (fig. 3).

The first symptoms of hopperburn are a slight yellowing, usually of the tip of a leaflet. As the disease progresses, the leaflet slowly turns brown, curls upward, and dies. The diseased condition spreads from the tip or margin toward the midrib of the leaflet, but spreads more slowly toward the base, and the basal area of leaves may remain green until the whole plant is nearly dead.

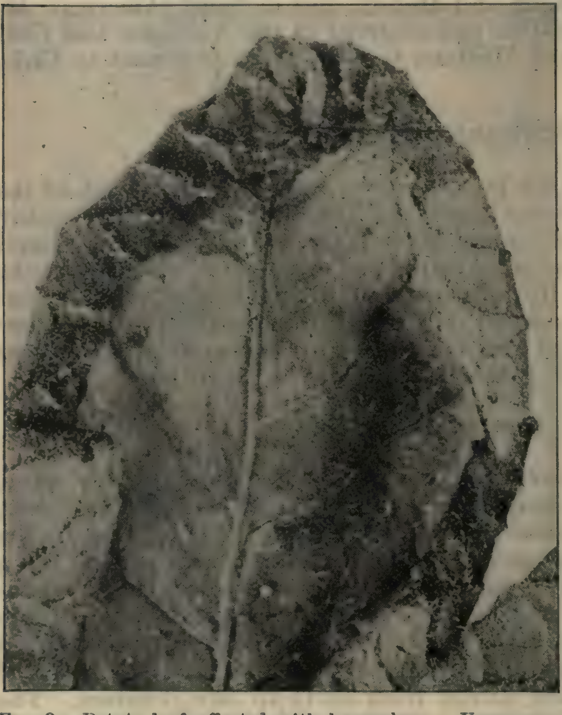

FIG. 3.—Potato leaf affected with hopperburn. Upper surface of leaf, showing typical upcurled brown tip and margin

During periods of hot, dry weather leafhoppers reproduce very rapidly; the females are stimulated to lay eggs faster and the nymphs develop in a shorter time. Thus, with a constantly increasing population, hopperburn spreads very rapidly. The effect of hopperburn combined with the effect of dry weather may kill whole fields of early potatoes in a week's time (fig. 4). On the other hand, during cool, moist weather, which slows down the increase of leafhoppers, and especially where protective sprays have been applied, the disease is checked, and throughout the summer it may progress no farther than the primary symptoms (fig. 5).

Observations made in Wisconsin have shown that whenever leafhoppers were present in potato fields hopperburn could be found, and that when no leafhoppers were present no hopperburn could be found. In other words, the leafhoppers and hopperburn are always found together.

HOW HOPPERBURN AFFECTS DIFFERENT VARIETIES

Leafhoppers placed on Early Triumph potato plants growing in a field and covered with a large cage caused hopperburn, which killed the plants in 23 days (fig. 6, A and B). Leafhoppers placed

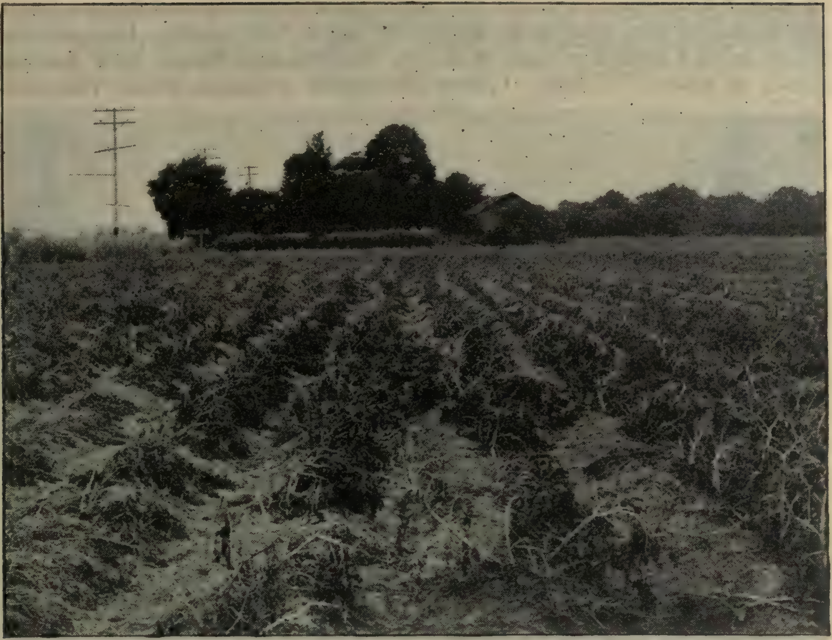

FIG. 4.—Early Ohio potatoes killed by hopperburn. Great abundance of leafhoppers and a period of hot, dry, July weather caused these potatoes to succumb to hopperburn in a short time

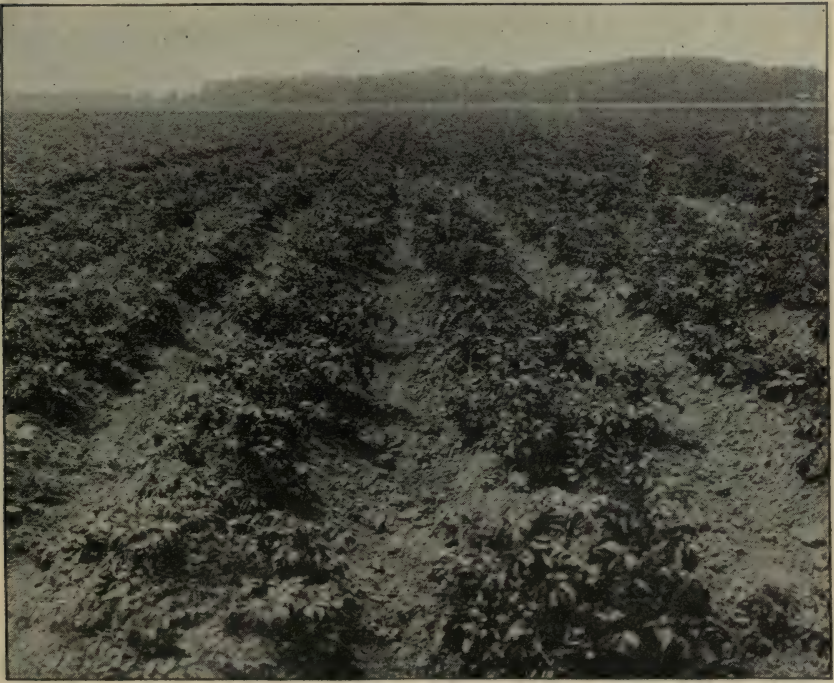

FIG. 5.—Main-crop potatoes protected from hopperburn by Bordeaux mixture. Two sprayings with Bordeaux mixture kept this field fairly free from hopperburn

on Early Ohio plants under the same conditions caused hopperburn, which killed the plants in about 40 days. Similarly, hopperburn killed Irish Cobbler plants in about 55 days and Rural New Yorker plants in about 50 days. Green Mountain potatoes under like conditions became badly diseased, but were still alive two months after the leafhoppers were placed on them.

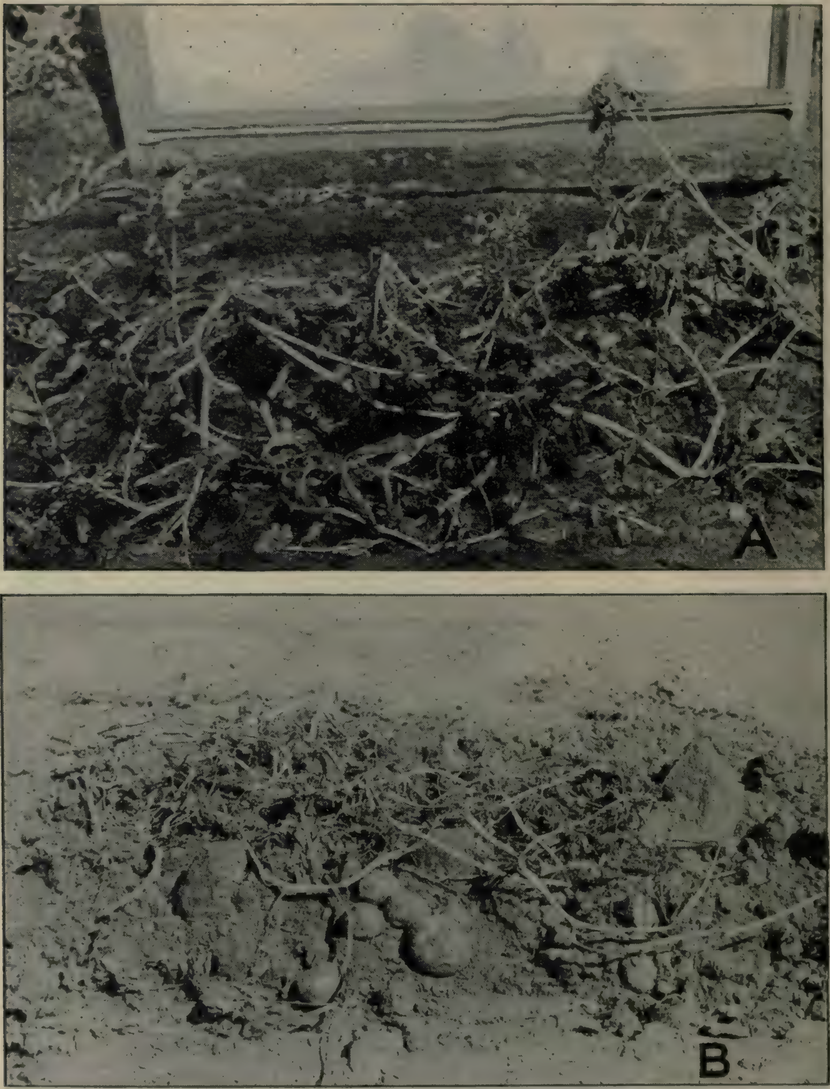

FIG. 6.—Presence of many leafhoppers means hopperburn. Triumph potatoes growing in field, covered with large cage containing leafhoppers for entire season. *A*, Condition of plants on August 14; B, condition of same plants when dug on September 2. Compare with Figure 7

Plants of all the foregoing varieties which were confined and kept free of leafhoppers showed no symptoms of hopperburn during a period of two months (fig. 7, A and B).

Observations made in several potato-growing sections of Wisconsin have shown that the Triumph variety is invariably more severely affected with hopperburn than any other variety grown commercially in that State. Usually the Rural New Yorker has been found to be the most resistant to hopperburn of any variety grown commercially in Wisconsin.

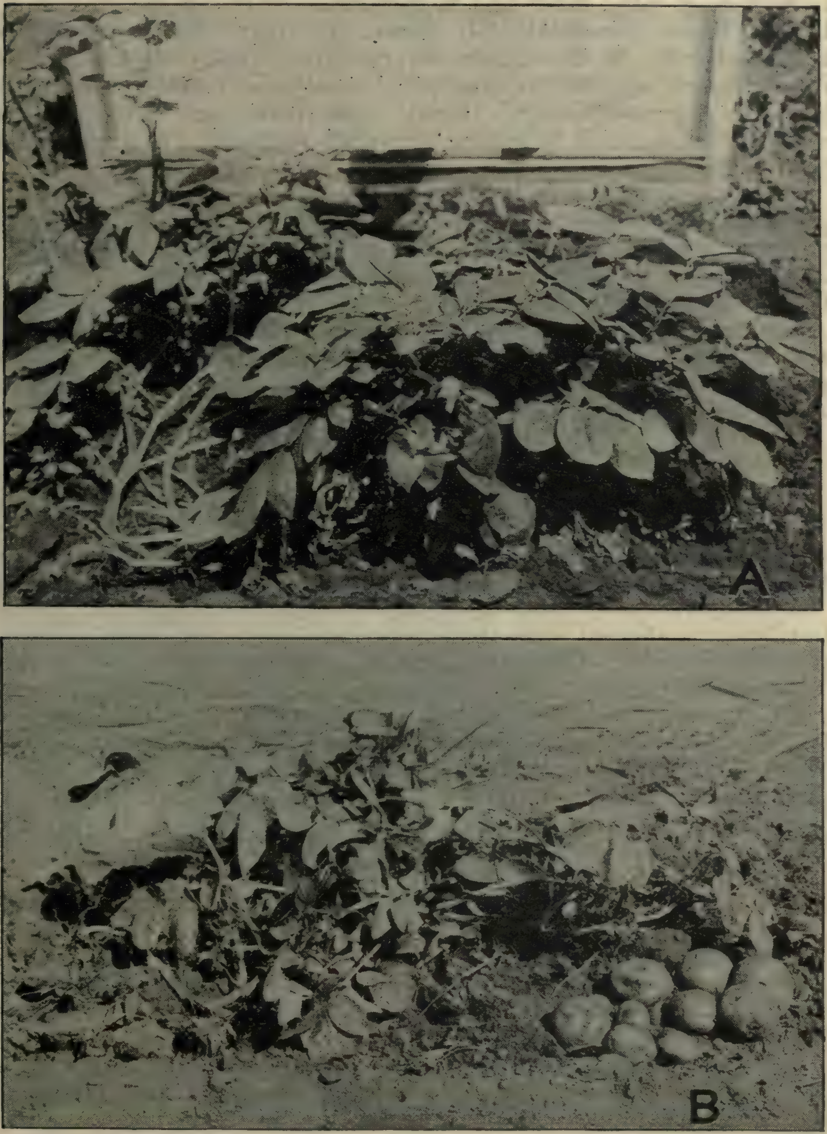

FIG. 7.—Absence of leafhoppers means no hopperburn. Triumph potatoes growing in field, covered with large cage for entire season and kept free of leafhoppers. A, Condition of plants on August 14 ; B, condition of same plants when dug on September 2. Compare with Figure 6

FOOD PLANTS

The potato leafhopper visits a considerable number of plants for feeding purposes. The more important economic plants on which reproduction takes place and hopperburn occurs are the following: Potato, beans (practically all varieties), sugar beet, hemp, apple, and raspberry. It also attacks several ornamental trees and shrubs. Reproduction appears to take place most readily on potato, with beans as a second choice. Hemp, sugar beets, and apple nursery stock are more liable to severe injury when growing near potato or bean fields.

String, pole, and navy beans are at times severely injured by hopperburn, and if the plants are not killed outright the yields are greatly reduced. Lima beans and soybeans are not so heavily attacked, nor is hopperburn ever severe on them; this is the case in Wisconsin, at least.

Not only are certain varieties of potatoes less severely affected with hopperburn than are others, but some plants of any one variety are found to be more resistant to hopperburn than are other plants of the same variety.

NATURAL ENEMIES

Although there are three known natural enemies of the potato leafhopper, none has become important as a control. One, a tiny insect parasite, breeds in the leafhopper eggs, but does not occur in sufficient numbers to reduce noticeably the number of leafhoppers.

A fungous disease attacks both adults and nymphs, or young. Leafhoppers affected with fungus[2] soon die and turn from green to yellowish in color. In a short time a heavy fungous growth, having colors of the rainbow, appears on the insect's body (fig. 8). Warm, moist weather is necessary for the growth and spread of this fungus. In 1919 it was common all over Wisconsin, and in certain localities practically exterminated the leafhoppers. In 1920, however, not a single specimen of the fungus was found. From 1920 to 1923 it has occurred sporadically, but has not been a factor in control. Spiders often prey on both adults and nymphs, or young.

CONTROL OF THE LEAFHOPPER AND PREVENTION OF HOPPERBURN

The results of six years' experiments show that Bordeaux mixture controls the leafhopper, killing many of the nymphs, or young, and repelling the adults. It is the best-known remedy for the prevention of hopperburn.

Bordeaux mixture combined with nicotine sulphate acts a little more quickly in ridding plants of leafhoppers than does Bordeaux alone, but the results obtained do not appear to justify the added time and expense of using the nicotine.

Nicotine sulphate combined with soap has been found very effective in killing nymphs, or young, and the few adults present at the time when the spray was applied. There was no lasting effect, however, because leafhoppers reappeared in a few days. Hopperburn was not controlled.

---

[2] *Entomophthora sphaerosperma.*

Kerosene emulsion acted in the same way as nicotine and soap, killing the leafhoppers which it hit, but having no lasting effect.

ACTION OF BORDEAUX MIXTURE

Bordeaux mixture properly applied to plants will kill nymphs, repel adults, and keep the plants free from them as long as a good coating of spray is kept on the foliage. Unsprayed plants growing next to properly sprayed plants, or even among them, will be heavily attacked by leafhoppers and become badly affected with hopperburn.

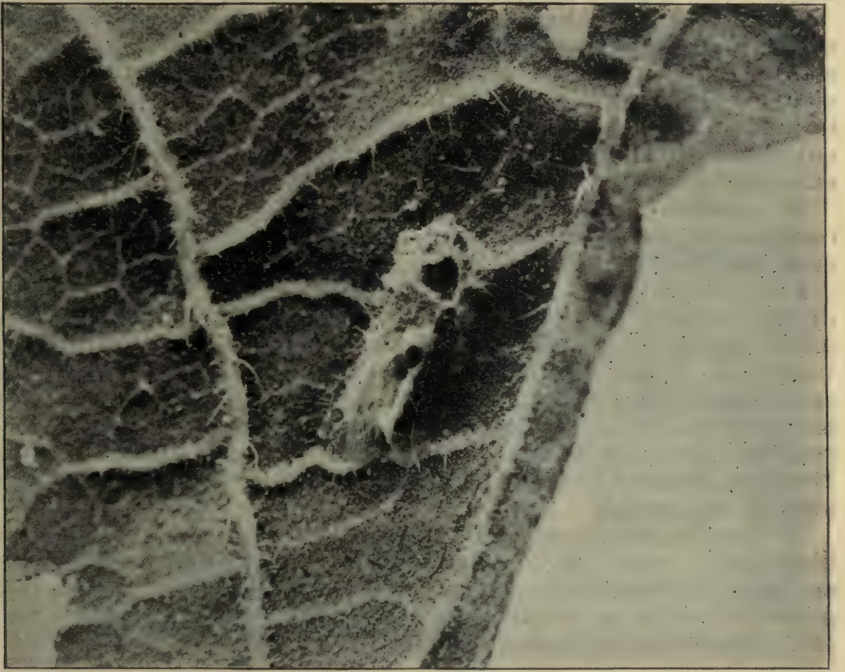

FIG. 8.—Fungous disease that checks leafhoppers. The fungus has a rainbowlike appearance after covering the body of the insect

The effect of Bordeaux mixture on hopperburn varies with different varieties. Rural New Yorker potato plants well sprayed have remained almost free of hopperburn until digging time. Triumph potatoes, on the other hand, while they were prevented from becoming badly diseased until after tubers had well developed, were affected much more by hopperburn than any other variety tested. Unsprayed Triumph plants died from the effects of hopperburn before the middle of the season. The five types of potatoes used, in order of their susceptibility to leafhopper attack and to hopperburn, were: Triumph, Irish Cobbler, Early Ohio, Green Mountain, and Rural New Yorker.

HOW TO PREPARE BORDEAUX MIXTURE

The ingredients and method of preparation of Bordeaux mixture are as follows:

Copper sulphate (bluestone)	pounds	4
Quicklime	do	4
Water to make	gallons	50

Prepare the copper sulphate or bluestone by suspending it in a gunny sack just below the surface of several gallons of water in a clean barrel. When the bluestone is dissolved, which requires three or four hours, remove the sack and stir into the barrel enough additional water to make exactly 25 gallons of the copper solution.

As the use of quicklime on the farm entails more or less trouble in storing and preparing, many growers are using hydrated lime instead. If it is fresh and of good quality, very good results may be obtained with it. It is easy to keep and to mix, and is usually easy to obtain. Six pounds of it should be used instead of the 4 pounds of quicklime. It should be mixed directly with enough water to make exactly 25 gallons.

If quicklime is used, slake it slowly and thoroughly in a small container, strain into a barrel, and add enough additional water to make exactly 25 gallons of lime milk.

Pour the two ingredients together into another barrel or, better, directly into the spray tank, if it will hold 50 gallons. It is highly important to stir the mixture very thoroughly and to strain both ingredients before they are combined, as otherwise clogging of the spray nozzles may result. Use copper or bronze wire strainer of 18 meshes to the inch. Do not put copper sulphate or Bordeaux mixture into tin or iron vessels; use wood or copper containers. Mix the Bordeaux solution as needed and apply at once. It is never so good after it has settled.

To prepare Bordeaux mixture in small quantities use 1 pound of bluestone, 1 pound of stone lime, or 1½ pounds of hydrated lime, and 12½ gallons of water, and proceed according to the directions just given for preparing 50 gallons of Bordeaux mixture, with the exception that smaller containers can be used.

STOCK SOLUTIONS

Everyone who uses Bordeaux mixture frequently and in quantity will find it convenient to keep on hand concentrated stock preparations of copper-sulphate solution and milk of lime in separate containers. These stock preparations keep indefinitely if the water which evaporates is replaced.

Build an elevated platform to hold the barrels. Some time before the day on which it is desired to commence spraying put 50 pounds of bluestone in a sack and hang it in a barrel with 50 gallons of water, to dissolve. Slake 50 pounds of quicklime, or mix 75 pounds of hydrated lime, in another barrel and add water to make 50 gallons of lime milk. When Bordeaux mixture is needed, stir both stock barrels and take from each as many gallons as the formula calls for in pounds. Dilute the copper sulphate in one barrel and the lime milk in another, each with half the water to be added, and let the two run together into the strainer of the spray tank. Thorough agitation is important in making a good Bordeaux mixture.

HOW AND WHEN TO APPLY BORDEAUX MIXTURE

To control the potato leafhopper, Bordeaux mixture *must* be applied to the under side of the leaves, and spraying must be done thoroughly, in order to cover practically all of the foliage. Each side of every row of plants must be sprayed (fig. 9).

A high pressure (at least 150 pounds) should be maintained in order to cover the leaves with a fine mist, which gives a much better coating than does a coarse spray (fig. 10).

In years when leafhoppers are abundant at least three applications of Bordeaux mixture should be made, the first as soon as the leafhoppers have appeared on the plants. Where necessary to control the Colorado potato beetle, add 1 pound of powdered arsenate of lead to each 25 gallons of the Bordeaux mixture. The second spray should be applied from 10 days to 2 weeks later, depending upon the amount of spray remaining on the plants and the amount of new growth. A third, and even a fourth, spray may be necessary in very hot, dry summers or in years when leafhoppers occur in vast numbers, but the time when these extra applications should be made must be determined by examinations of each field.

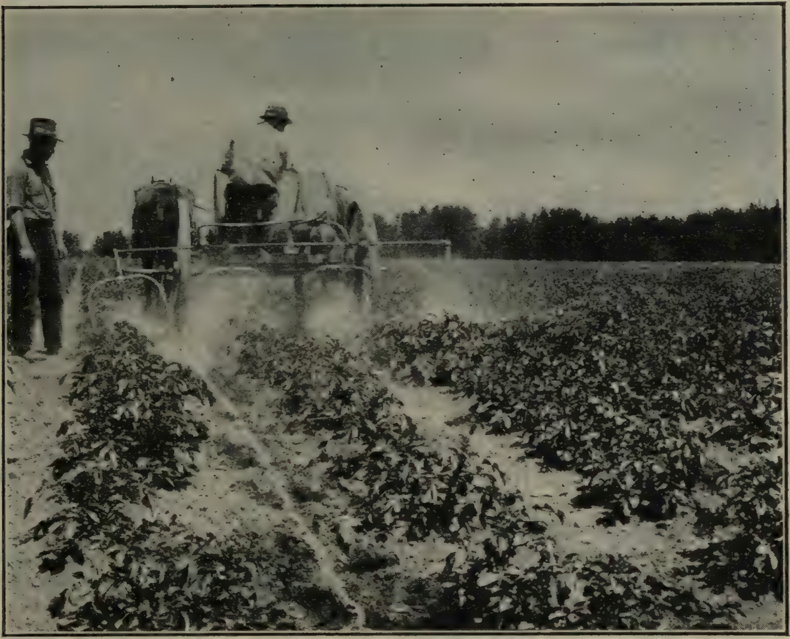

FIG. 9.—Spraying potatoes properly. A high pressure is needed, and three nozzles should be used for each row, the outer two directing the spray upward and inward. In experiments carefully performed, four such sprayings increased the yield of potatoes 44½ per cent over the yield obtained when two nozzles per row were used, directing the spray downward

As Bordeaux mixture is used for several purposes on potatoes—to repel flea beetles and control certain plant diseases—it is most fortunate that it has been found to be a control for leafhoppers and hopperburn, and it may fit nicely into the regular spraying schedule.

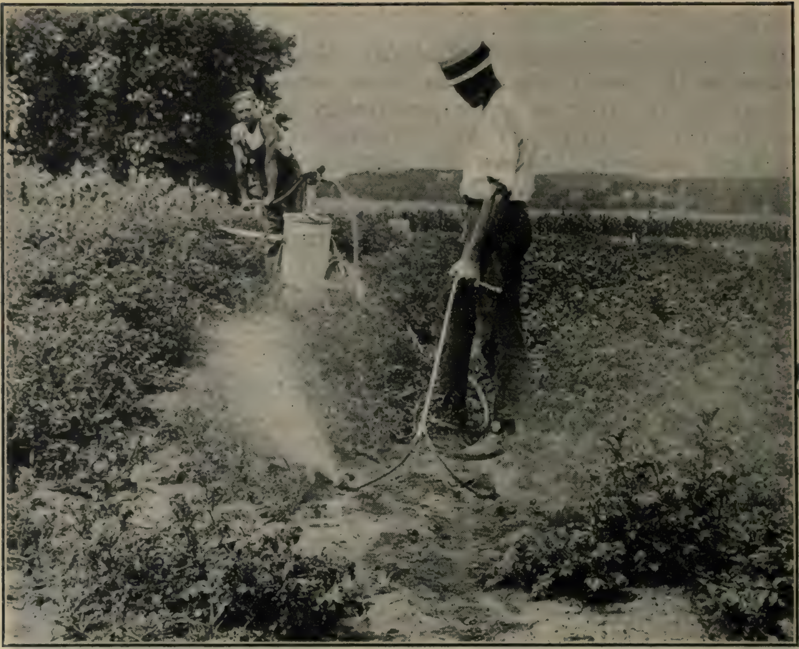

FIG. 10.—The wheelbarrow sprayer is effective for small patches. The boom carries two nozzles

SUMMARY OF CONTROL MEASURES

Spraying with Bordeaux mixture appears to be the only practical method of control for the potato leafhopper and for preventing the appearance or spread of hopperburn.

The 4-4-50 formula is generally used.

It should be thoroughly applied to the *under side* of the leaves, at least 150 pounds pressure being used, so that a fine mist spray will result.

Make at least three applications, and spray a fourth time if necessary to keep down hopperburn until the crop has matured.

To make the application thorough, spray both sides of each row.

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January 12, 1926

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1463

SUCCESSFUL FARMING ON 160-ACRE FARMS IN CENTRAL INDIANA

THIS BULLETIN is primarily a story of the organization and management of 160-acre farms in central Indiana and similar adjacent sections.

Corn, oats, or wheat, and clover, or clover and timothy are the principal crops. Most of the small grains are sold as cash crops, and the corn and clover (both hay and pasture) are fed to hogs, cattle, work animals, sheep, and poultry. Hogs get the largest share.

Some of the principles of good farm organization and management on 160-acre farms are illustrated by the facts brought out regarding what the successful farmers on 160-acre farms have accomplished, not in a single year but over several years.

The bulletin sets before the 160-acre farmers standards which some farmers have reached and which are believed to be within the reach of a great many other 160-acre farmers in this section and similar sections near it.

A discussion of successful farming on 80-acre farms in central Indiana has been published as Farmers' Bulletin 1421, and data are available for similar discussions of 120-acre and 240-acre farms.

Washington, D. C. Issued August, 1925

SUCCESSFUL FARMING ON 160-ACRE FARMS IN CENTRAL INDIANA

By Lynn Robertson, *State Leader, Farm Management Demonstrations, Purdue University*, and H. W. Hawthorne, *Associate Agricultural Economist, Bureau of Agricultural Economics*

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INCOMES MADE FROM 160-ACRE FARMS

THE more efficient 160-acre farmers in central Indiana (fig. 1) make good incomes over a period of years. Records of the year's business on 400 farms from 1910 to 1922 show that the best 10 per cent of the 160-acre farmers have made an average yearly income sufficient to cover 5 per cent interest on their capital and $1,465 for their labor and management, and in addition have obtained from the farm an important share of the family living in the way of milk, meat, poultry, eggs, vegetables, fruit, fuel, and house rent, the value of which, at farm prices, was $605.

Variation in economic conditions influences the incomes made. Most of the 160-acre farmers make "good money" during such periods of agricultural prosperity as was experienced from 1916 to 1919. During more normal periods, such as occurred from 1910 to 1915, about half of them make as much as 5 per cent on their capital and a wage of $300 for their labor, in addition to the family living from the farm. Only an occasional 160-acre farmer in central Indiana does so well during periods of depression, such as started in 1920, but some farmers made money even then. For example, a 160-acre farmer in Clinton County, who had been shown by eight years' previous records to be a good farmer, averaged a farm income of nearly $2,000 per year for the years 1920 to 1923.

The figures from seventeen 160-acre farms in Clinton County for eight years in Table 1 are representative.

Table 1.—*Average receipts, income, and value of family living furnished by the farm from seventeen 160-acre farms in Clinton County, Ind.*

	Farm receipts	Farm income	Labor income	Per cent on capital	Value of family living furnished by farm
1910	$2,564	$1,581	$286	4.7	$317
1913	2,828	1,902	421	5.2	332
1914	2,558	1,455	−38	3.6	307
1915	2,966	1,772	224	4.5	327
1916	3,723	2,449	828	6.4	406
1917	4,398	2,739	1,093	7.2	492
1918	5,735	3,578	1,617	7.5	665
1919	5,802	3,239	1,336	6.5	638
Average of 8 years	3,849	2,357	737	5.7	438
Average of the 4 most successful farms	5,265	3,145	1,332	7.2	622
Average of the 4 least successful farms	2,961	1,845	313	4.5	358
Average of the most successful farm	6,696	3,448	1,632	8.5	737
Average of the least successful farm	2,446	1,513	59	3.7	327

Note.—Average capital, 1910 and 1913 to 1915: Real estate, $26,203; other, $2,882; total, $29,085. 1916 to 1919: Real estate, $31,559; other, $4,096; total, $35,655.

Receipts are the value of all the products sold from the farm, plus any increased value of livestock due to growth or increase in numbers and plus the value of any increased quantity of feed at the end of the year over the beginning of the year.

The *farm income* is the receipts less the expenses (the expenses including all costs except any charges for the farmer's own labor and for interest on the capital), and represents the combined returns for the use of the capital and the farmer's labor, exclusive of the family living furnished by the farm.

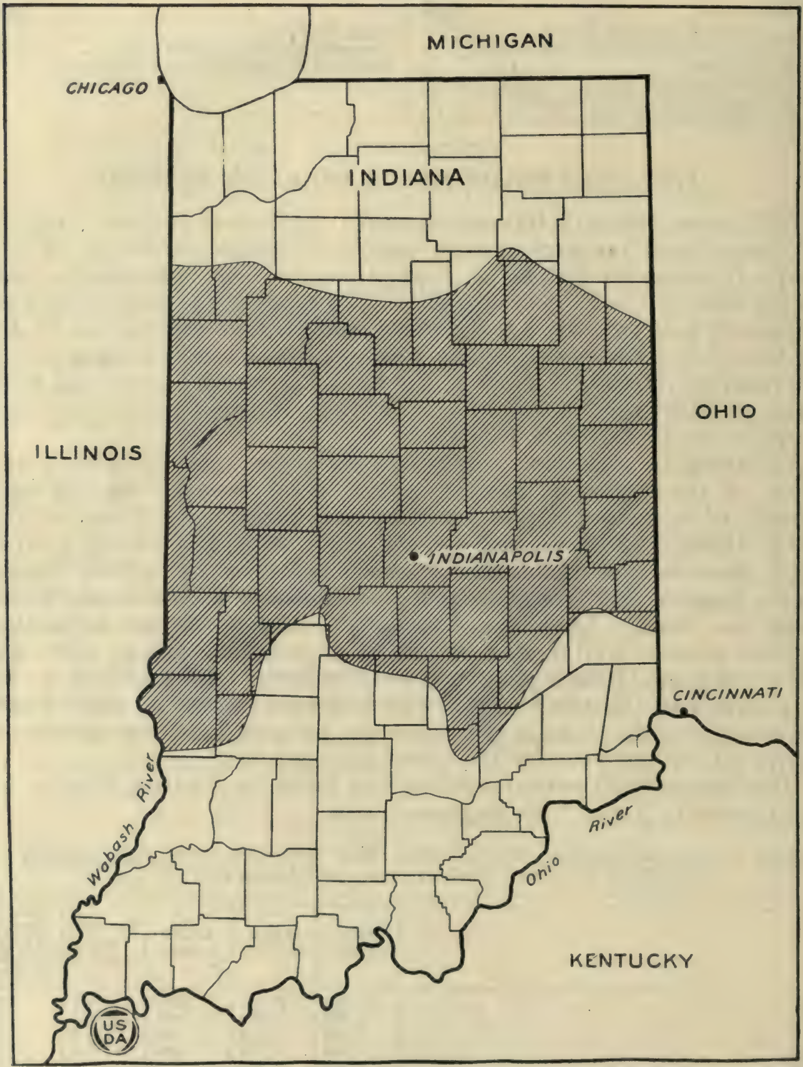

FIG. 1.—The shaded portion of the map shows the part of Indiana to which the discussion in this bulletin particularly applies

The *labor income* is the farm income less 5 per cent interest on the capital. It represents the pay the farmer gets for his year's labor, exclusive of any of the family living furnished by the farm.

The *per cent on capital* is the farm income less the value of the farmer's own labor and expressed as per cent of the capital. It represents the returns to capital after allowing the farmer's estimate of the value of his own labor.

The *value of the family living furnished by the farm* represents the meat, milk, eggs, fruit, vegetables, etc., set aside from the farm production for family use, and the fuel and house rent furnished by the farm.

VARIATIONS IN INCOMES FROM 160-ACRE FARMS

Only a moderate return for the capital and farmer's labor is realized from the average 160-acre farm, but there is a wide variation in the profits made from different farms. From the most successful 160-acre farm in the Clinton County group for which figures are presented in Table 1, there was an average farm income of $3,448 per year for eight years, as compared with $1,513 per year from the least successful farm.

A comparison of the more successful with the less successful 160-acre farms in a community shows some of the reasons for the greater success of some farmers.

This bulletin points out the systems of farming and some of the more important practices followed on successful 160-acre farms in contrast to those on less successful ones. The discussion is based on the results from all of the 160-acre farms in central Indiana from which records have been obtained, and is frequently illustrated with facts from the four most successful and the four least successful 160-acre farms in the Clinton County area.

FARMING SYSTEMS

No one type of farming is always the most profitable. At least three fairly distinct types are followed to advantage on 160-acre farms in central Indiana and similar adjacent areas. Since much the same crops are grown on all the 160-acre farms the types may be classified according to the livestock as in Table 2.

TABLE 2.—*Farming systems common on 160-acre farms in central Indiana*

	The hog system		The hog and beef cattle feeding system		The hog and dairy system	
	Range	More common	Range	More common	Range	More common
	Head	*Head*	*Head*	*Head*	*Head*	*Head*
Brood sows	5 to 25	15	5 to 15	10	3 to 15	7
Boars	1 to 2	1	1	1	0 to 1	1
Pigs raised	45 to 225	135	45 to 135	90	27 to 135	63
Dairy cows	2 to 6	4	2 to 6	4	7 to 25	15
Young cattle	0 to 4	2	0 to 4	2	3 to 9	6
Bull	0 to 1	0	0 to 1	0	0 to 1	1
OR—						
Dual-purpose cows	3 to 6	5	3 to 12	6	--------	--------
Young cattle	0 to 8	2	0 to 8	2	--------	--------
Bull	0 to 1	1	0 to 1	1	--------	--------
Feeding cattle	--------	--------	10 to 40	20	--------	--------
Sheep	0 to 60	0	0 to 60	0	0 to 60	0
Work animals	4 to 8	6	4 to 8	6	4 to 8	6
Hens	75 to 300	125	75 to 300	125	75 to 300	125

The prevalence of level to gently rolling land (fig. 2) that produces good crops of corn is largely responsible for making hogs an important part of the farm business on nearly all of the farms, and the "hog" system is most common on the successful 160-acre farms. The "hog and beef cattle feeding" system and the "hog and dairy" system are followed to advantage on some farms.

THE HOG SYSTEM

The hog system is discussed in detail, while each of the others are discussed only in so far as they vary from it.

CROP ROTATION

In the hog system of farming there are from 5 to 20 acres in woods or other permanent pasture (fig. 3), about 3 acres in farmstead, and 3 acres in lanes, roads, etc., leaving from 134 to 149 acres for crops on most 160-acre farms in central Indiana. The most common rotation is one of three years. Corn, wheat, oats, or rye; clover, or clover and timothy are the principal crops. (See fig. 4.)

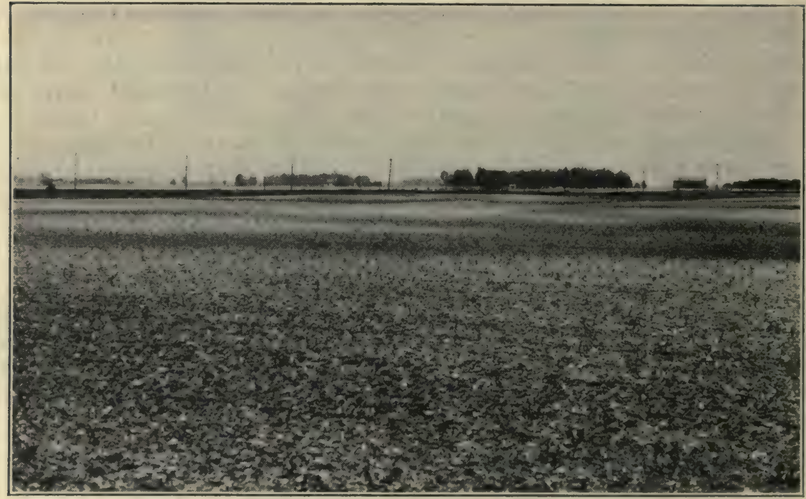

FIG. 2.—Typical topography in central Indiana

Other less common but good rotations are (1) corn, corn, wheat, oats or rye; clover, or clover and timothy, and (2) corn, corn, soy beans, wheat, clover or clover and timothy.

On thin soils a four-year rotation—corn, wheat, oats or rye, and two years of clover and timothy; or, corn, soy beans, wheat, and clover or clover and timothy—is favorable to maintenance of soil fertility, but neither this nor the four-year rotation of corn, oats, wheat and clover followed by some farmers, furnishes as much corn as is desirable with the amount of livestock giving best returns.

The four-year rotation of corn, corn, wheat, oats or rye; clover or clover and timothy is objected to by some farmers on the grounds that two years in corn is too hard on the land. However, most farmers who follow this rotation find that the two years of corn following clover sod on strong land does not reduce yields, especially when the corn is "hogged off" at least one of the years and when the stalks are plowed under and not burned. On land not naturally strong this rotation is not generally advisable.

The five-year rotation of corn, corn, soy beans, wheat, clover or clover and timothy has recently gained favor on some of the successful farms for the following reasons: (1) 40 per cent of the crop land is devoted to corn without endangering fertility, as 40 per cent of the land is in legumes; (2) wheat following soy beans usually yields higher than when following other crops; (3) soy beans furnish home-grown protein feed for hogs and cattle. The elasticity in disposing of the soy-bean crop either as hay or grain feed or as a cash crop aids in adjusting the total feed production to the feed requirements of the livestock.

FIG. 3.—A woods pasture of 5 to 20 acres is common on most of the 160-acre farms in central Indiana. It is an asset to the farm, even though remote from the farmstead, as it furnishes shade and pasture for the livestock as well as the family supply of firewood

On the four most successful farms in the Clinton County group there was an average of 55 acres in corn, 42 acres in small grains, and 40 acres in clover and timothy per farm (Table 3). Thus the percentage of land in corn was more than a strictly three-year rotation affords. Most of the successful men living on productive farms want more than a third of their crop land in corn and plan to get it either by having two years of corn in succession in the rotation or by having a field outside of the regular rotation in which corn or corn and soy beans are planted year after year for "hogging off." Failures of clover, with the practice of putting the land on which the clover failed back to corn, also increased the acreages in corn.

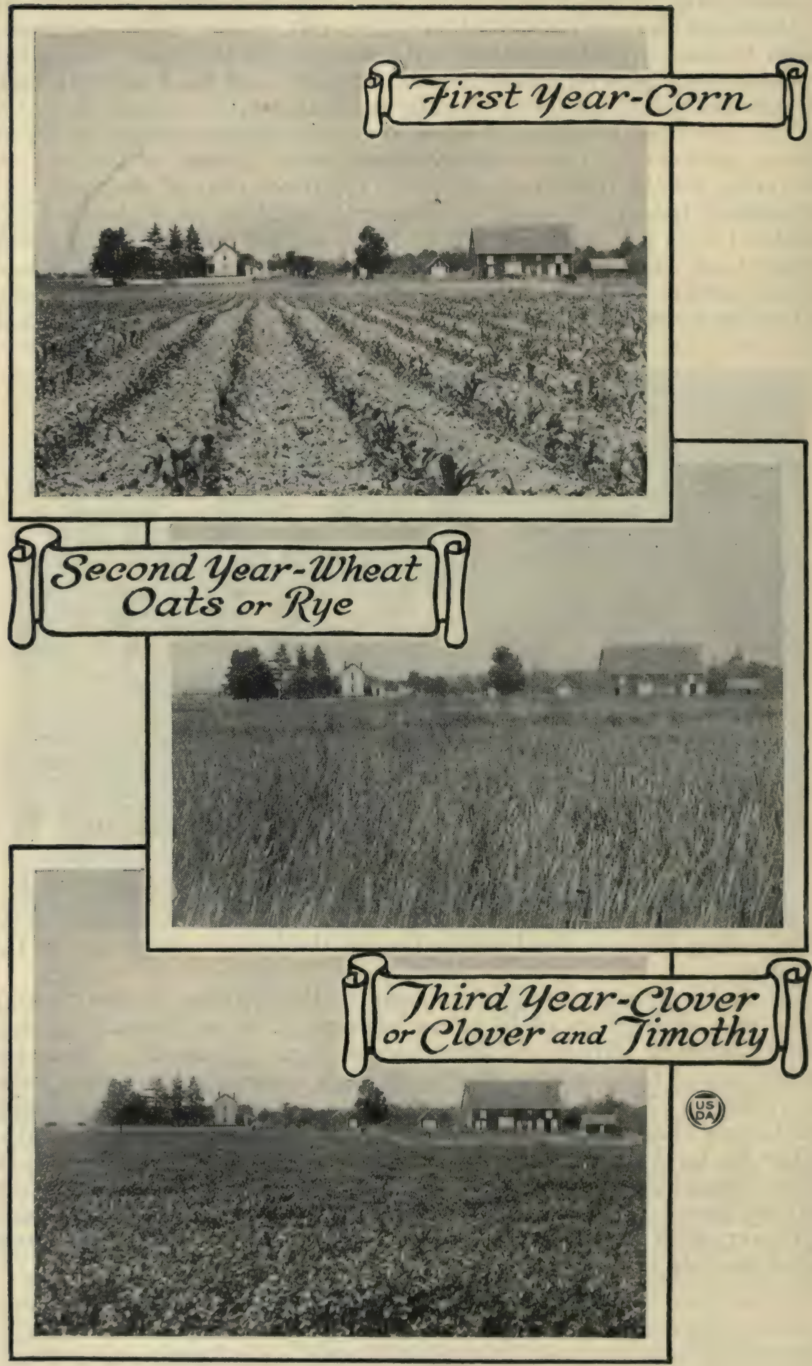
First Year-Corn
Second Year-Wheat Oats or Rye
Third Year-Clover or Clover and Timothy

FIG. 4.—The usual cropping system on 160-acre farms in central Indiana

TABLE 3.—*Acres in crops on the 4 most successful and the 4 least successful 160-acre farms in the Clinton County study—8-year average*

	Corn	Small grains	Clover, or clover and timothy	Total rotation land		Corn	Small grains	Clover, or clover and timothy	Total rotation land
	Acres	*Acres*	*Acres*	*Acres*		*Acres*	*Acres*	*Acres*	*Acres*
Farm 1	50	40	40	130	Farm 5	57	41	33	131
Farm 2	57	39	35	131	Farm 6	52	43	51	146
Farm 3	51	48	47	146	Farm 7	54	46	33	133
Farm 4	61	43	39	143	Farm 8	55	47	35	137
Average of 4 most successful farms	55	42	40	137	Average of 4 least successful farms	55	44	38	137

UNIFORM CROP SYSTEM DESIRABLE

The men on the more successful farms varied less, annually, from their regular system of cropping than those on the less successful farms. For example, the figures for eight years in Clinton County show an average yearly variation of 14 per cent in acreage of corn on the four most successful 160-acre farms and 21 per cent on the four least successful. There were correspondingly greater variations in the acreages of other crops on the poorer paying farms. Differences in yields due to varying seasons cause fluctuations in total production of crops from year to year; and when this fluctuation is increased by variations in acreages it becomes increasingly difficult to make the feed production on a farm fit in with the livestock kept. The livestock must be varied greatly from year to year or considerable more feed must be bought or sold one year than another. Variations of this kind, not made to meet changes in economic conditions, are not desirable.

Haphazard variations in farm organization with no relation to changes in prices of the things farmers sell and buy is very undesirable, and must not be confused with changes intelligently planned to meet variation in the economic situation. For those farmers who keep informed regarding trends in supply and demand with regard to the products affecting their farming business a somewhat flexible system is desirable permitting the production of products for which the demand will be strongest. But unless changes are made on the basis of the best economic information available, they more often result in damage than in benefit.

FARM LAYOUTS

Failure of clover is a common cause of fluctuation in acreage of each crop from year to year, but the division of the farm into fields also has an influence.

The most successful farmers have their farms laid out in such a way that it is possible to follow a fairly definite system and obtain nearly uniform acreages of each crop from year to year. The best laid-out farms are those with as many fields of equal size as there are years in the rotation or with fields which can be combined in such a way as to divide the crop acreage into as many equal parts as there are years in the crop rotation. Thus, three fields, each of 45 to 50 acres, accommodate a three-year rotation to best advantage on 160-acre farms; and four fields, each of from 33 to 37 acres, fit a four-year rotation.

In addition to making it possible to follow a more uniform farming system, good farm layouts economize in labor requirements and in amount of fencing. Large fields, from one and one-half to three times as long as wide, are most economical.

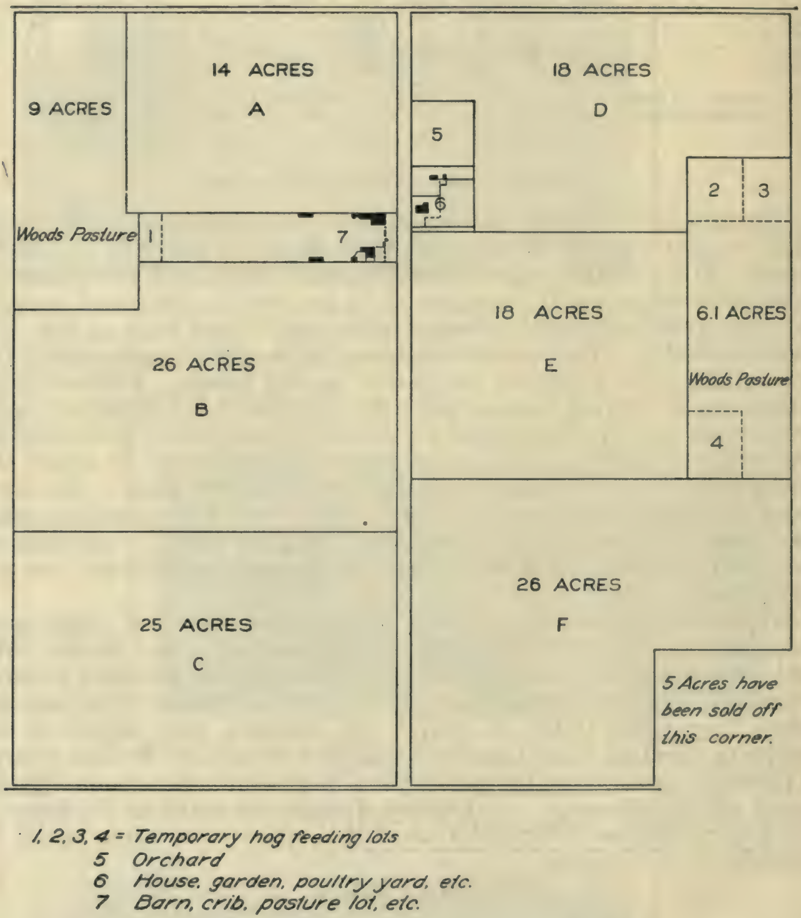
14 ACRES
A
9 ACRES
Woods Pasture
1
7
18 ACRES
D
5
6
2
3
26 ACRES
B
18 ACRES
E
6.1 ACRES
Woods Pasture
4
25 ACRES
C
26 ACRES
F
5 Acres have been sold off this corner.
1, 2, 3, 4 = Temporary hog feeding lots
5 Orchard
6 House, garden, poultry yard, etc.
7 Barn, crib, pasture lot, etc.

FIG. 5.—The layout of a successful 160-acre farm in central Indiana

The layout of one of the most successful 160-acre farms in the Clinton County group is shown in Figure 5 and a suggestive layout for a three-year rotation in Figure 6.

The field arrangement in Figure 5 allows practically the same acreages of corn, small grains, clover and timothy each year.

In 1919 fields A and F were in corn. In the fall, field F was sown to wheat, and the following spring field A to oats, a seeding of clover and timothy going on each field. Thus, both fields were in small grain in 1920 and in clover and timothy in 1921, when field F was pastured and field A cut for hay. In 1922 both fields were again in corn.

For the 1920 crops, the farmer had the choice of putting the smaller field in oats and the larger one in wheat, of putting the smaller field in wheat and the larger one in oats, of putting both fields in wheat, or of putting both in oats. He put the smaller field in oats and the larger in wheat. In 1921 he had the choice of cutting the smaller field for hay and pasturing the larger one, of pasturing the smaller field and cutting the larger for hay, of pasturing both fields, or of cutting both for hay. He cut the smaller field for hay and pastured the larger one.

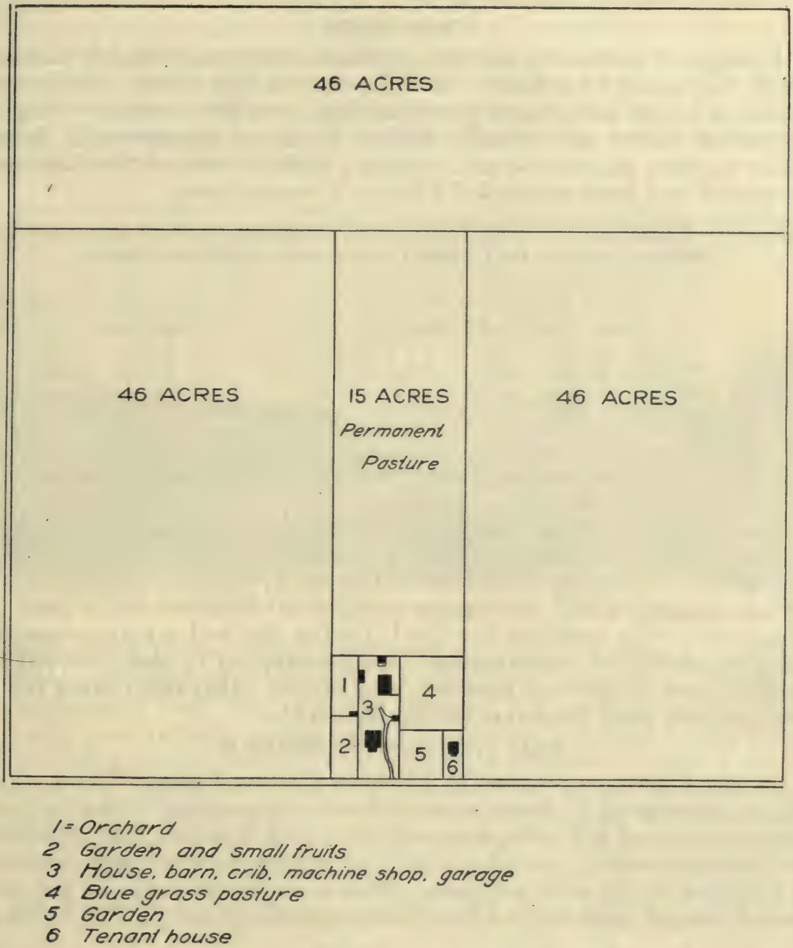

FIG. 6.—A suggested layout for a three-year rotation on 160-acre farms in central Indiana

In 1920, when fields A and F were in small grains, fields B and D were in corn; in 1921, when fields A and F were in clover and timothy, fields C and E were in corn.

Soy beans have been planted with the corn in the smaller fields since 1920. From 4 to 6 acres of the crop have been put into the silo and the rest "hogged off." The crop from the larger cornfields has been husked from the standing stalk.

In Figure 6 the rotation fields are of equal size and well shaped for economical operation. Each field is accessible from the permanent pasture even though any field be temporarily divided, as for "hogging off" corn or separating the rotation pasture from the hay land. Fencing is reduced to a minimum.

CROP YIELDS

Acreage of each crop on the profitable and unprofitable farms is much the same, but there is a difference in the yields. High crop yields alone do not insure good incomes, yet the average yields on successful farms are usually higher than on unsuccessful farms. Table 4 shows the eight-year average yields on each of the four most successful and least successful Clinton County farms.

TABLE 4.—*Yields per acre on the four most successful and the four least successful 160-acre farms in the Clinton County study—eight-year average*

	Corn	Oats	Wheat	Hay		Corn	Oats	Wheat	Hay
	Bush.	*Bush.*	*Bush.*	*Tons.*		*Bush.*	*Bush.*	*Bush.*	*Tons.*
Farm 1	48	44	[1]18 (1)	1.5	Farm 5	46	41	17 (3)	1.1 (7)
Farm 2	48	41 (7)	21 (4)	1.5	Farm 6	48	48	16 (3)	1.4
Farm 3	53	40 (7)	17 (6)	1.5	Farm 7	43	40	20 (1)	1.2 (6)
Farm 4	51	43 (5)	20 (7)	1.3	Farm 8	39	33 (7)	18 (4)	1.1 (5)
Average of the four most successful farms	50	42	19	1.4	Average of the four least successful farms	44	40	18	1.2

[1] When a crop was not grown every year on a farm, the number of years it was grown is indicated by the figure in parentheses.

The men who obtain consistently high yields usually follow what are generally recognized as good practices in connection with crop production. Keeping considerable livestock, conserving and returning the manure to the soil, using commercial fertilizer on at least the wheat crop, tile draining the land, liming the soil where necessary, using good seed of varieties and strains adapted to local conditions, treating seed to prevent diseases, and proper cultivation are a few of the methods used to obtain profitable yields.

WHAT LIVESTOCK IS DESIRABLE

On the four most successful 160-acre Clinton County farms, there was an average of 15 brood sows on hand in the spring from which 133 hogs were raised per year, 6 cows from which 5 calves were produced per year and usually vealed or kept to replenish the herd, and 125 hens, in addition to the work animals. This is approximately 78 per cent more livestock than on the four least successful farms. (See Table 5.)

TABLE 5.—*Livestock on the four most successful and the four least successful 160-acre farms in the Clinton County study—eight-year average*

	Cows	Sows	Ewes	Hens		Cows	Sows	Ewes	Hens
	No.	*No.*	*No.*	*No.*		*No.*	*No.*	*No.*	*No.*
Farm 1	7	20	------	200	Farm 5	3	8	------	70
Farm 2	5	9	([1])	100	Farm 6	8	9	------	120
Farm 3	7	14	------	150	Farm 7	5	12	------	85
Farm 4	4	15	------	50	Farm 8	3	6	------	85
Average of four most successful farms	6	15	([1])	125	Average of four least successful farms	5	9	------	90

[1] Ten ewes and a ram were kept on farm 2 for four years. On the average 10 lambs a year were raised for three years, and 109 pounds of wool a year were sold for four years.

One of the four most profitable farms had enough livestock to consume an average of 1,251 bushels of purchased corn per year in addition to the 2,400 bushels grown on the farm. (Fig. 7) The average amount of corn consumed yearly was 2,762 bushels on the four most successful farms and 2,015 bushels on the four least successful. The greater amount of livestock helped the profits on the most successful farms by increasing the volume of business, by providing profitable employment when labor could not otherwise be fully utilized, by helping maintain soil fertility economically, and by consuming unmarketable roughages and by-products.

It must not be assumed that the amount of livestock can be increased indefinitely and a corresponding increase in income result. An amount of livestock in excess of the maximum necessary to utilize by-product labor and feed must necessarily be produced on higher-priced labor and feed and the profits therefore be reduced, unless a special market is available.

FIG. 7.—Hogs almost ready for market on a successful 160-acre farm

Although a fairly uniform livestock system is desirable, there are probably greater opportunities to vary the livestock organization to advantage than the cropping system, for livestock prices vary in much more definite cycles than do most crop prices, the crop prices depending more on weather and climatic conditions. With a knowledge of the livestock cycles and the situation at any given time, a farm operator can often vary his livestock program to advantage; but, without such information, he is likely to let favorable prices influence him to increase in some enterprise when he should be decreasing, or he lets low prices discourage him when he should be getting products ready to sell at the higher price that follows.

LIVESTOCK PRODUCTION IS IMPORTANT

Usually no other single factor has a greater influence on comparative profits, from one 160-acre farm to another in this area, than the livestock returns per head. An average of 160 pounds of butterfat per cow was produced on the four most successful Clinton County farms, and 93 pounds on the four least successful; a calf per cow every 14 months as compared with one every 15 months on the least successful farms; 8.9 pigs per sow per year as compared with 6.6

on the least successful farms; 63 eggs per hen per year as compared with 58 on the least successful farms, and 1.8 chickens were raised for each hen kept on the most successful farms as compared with 1.2 on the least successful farms. The total livestock production per farm on the successful and unsuccessful farms in the Clinton County group is given in Table 6.

TABLE 6.—*Livestock production on the four most successful and the four least successful 160-acre farms in the Clinton County study—eight-year average*

	Calves raised	Butter-fat equivalent produced	Hogs raised	Hogs bought (sows, boars, or shotes for feeding)	Chickens sold and used by family	Eggs sold and used by family
	Number	*Pounds*	*Number*	*Number*	*Number*	*Dozens*
Farm 1	5	946	158	30	297	890
Farm 2	4	651	117	3	164	659
Farm 3	6	1,300	132	1	306	793
Farm 4	4	465	125	6	138	289
Average of four most successful farms	5	840	133	10	226	658
Farm 5	3	280	41	12	125	468
Farm 6	7	500	63	1	81	533
Farm 7	4	686	90	8	142	404
Farm 8	3	400	42	1	82	342
Average of four least successful farms	4	466	59	5	108	437

HOG MANAGEMENT

Feeding.—Feeding practices are responsible for an important part of the difference in livestock returns. Successful farmers recognize that most farm feeds are deficient in protein and therefore purchase protein concentrates to supplement the home-grown feeds and make a more nearly balanced ration. During the eight years the four most successful Clinton County farmers purchased an average of 1,400 pounds of tankage per farm a year as compared with less than 100 pounds purchased by the least successful farmers, and 3,568 pounds of mill feed as compared with 510 pounds by the least successful farmers. During recent years some successful farmers reduced their bill for purchased concentrates by raising soy beans for hog feed, especially for "hogging down" with corn. When a mineral mixture of 10 parts of wood ashes or finely pulverized limestone, 10 parts of 16 per cent acid phosphate, and 1 part common salt is fed in a self-feeder (fig. 8), in addition to soy beans and corn, the soy beans prove practically as effective as tankage or skim milk as a source of protein.

Skim milk is used to a limited extent on some of the farms to supply protein to balance the corn, but in the hog system, where but few cows are kept, the limited amount of skim milk available can usually be fed to the poultry to better advantage.

With the feed rations recommended by Purdue University, in which spring shotes on full pasture receive 5 per cent by weight and fall shotes 10 per cent of the grain ration in the form of tankage, there would be required, on a farm with 15 sows and 135 hogs grown to 200 pounds in weight, approximately 9,700 pounds of tankage or its equivalent in skim milk or soybeans. In substituting soy beans or skim milk, 1½ to 2 pounds of soy-bean meal or 13 pounds of skim milk may be considered equal to 1 pound of tankage.

Vaccination.—The successful 160-acre farmers give more attention to hog vaccination than the less successful ones. One of the four most successful men in Clinton County lost 130 hogs from cholera the first year for which records are available. After losing 35 the next year, he had the remaining 82 head vaccinated and saved them all. He has vaccinated every year since. Another of the four most successful farmers has his hogs vaccinated every year regardless of whether there is cholera in the community. The other two vaccinate only when their hogs are threatened with cholera. The four least successful farmers spent only about one-third as much for vaccination as the four most successful farmers and lost more hogs. One of them had no hogs vaccinated during the eight years.

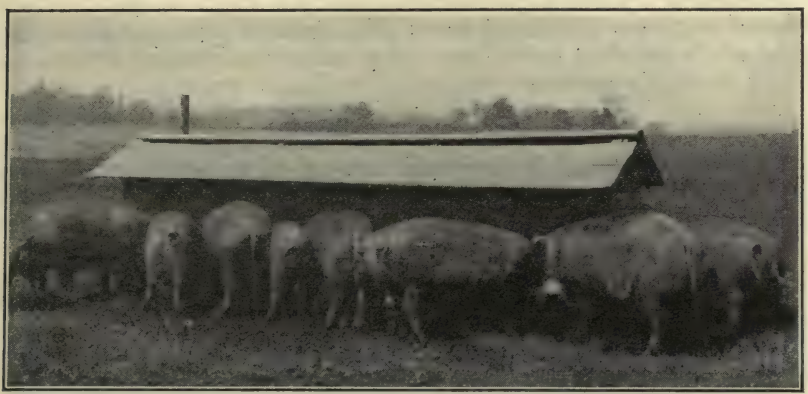

FIG. 8.—Self feeders are used on many of the successful 160-acre farms in central Indiana

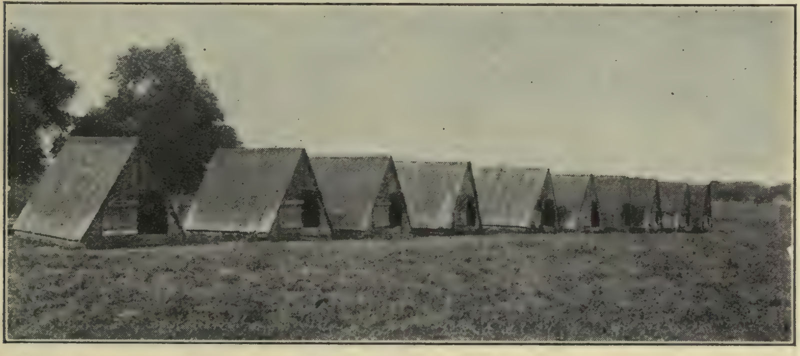

FIG. 9.—Successful 160-acre "hog" farmers usually prefer individual hog houses to the centralized house. They avoid crowding, may be readily shifted from one part of the farm to another to lessen danger of infection, are often made by the farmers themselves, and cost less than the centralized house

Farrowing.—On a few of the successful farms, gilts are used almost entirely for raising pigs in order to eliminate dockage when marketed; but records show that on most of the more successful 160-acre farms two litters are raised per year from older sows, one litter coming about March and the other about September. The majority of the successful men prefer individual hog houses for farrowing quarters (fig. 9), as they can be moved from field to field and thus lessen danger of infection. For the same reason the number of permanent hog lots is limited on most of the successful 160-acre farms, the farmers preferring to shift the hogs from field to field as much as possible. However, a few have small fields in which rotated crops are grown for hog forage.

Marketing.—Over a period of years the hogs on the successful farms have been marketed at weights around 200 pounds or more, although when hog prices are unfavorable as compared with corn prices there is a tendency to market at lighter weights.

POULTRY MANAGEMENT

Poultry has contributed average sales of $223 per year per farm on the four most successful farms in the Clinton County group in addition to furnishing the families $86 worth of eggs and meat. In recent years increased attention is given to the poultry enterprise and better practices are followed.

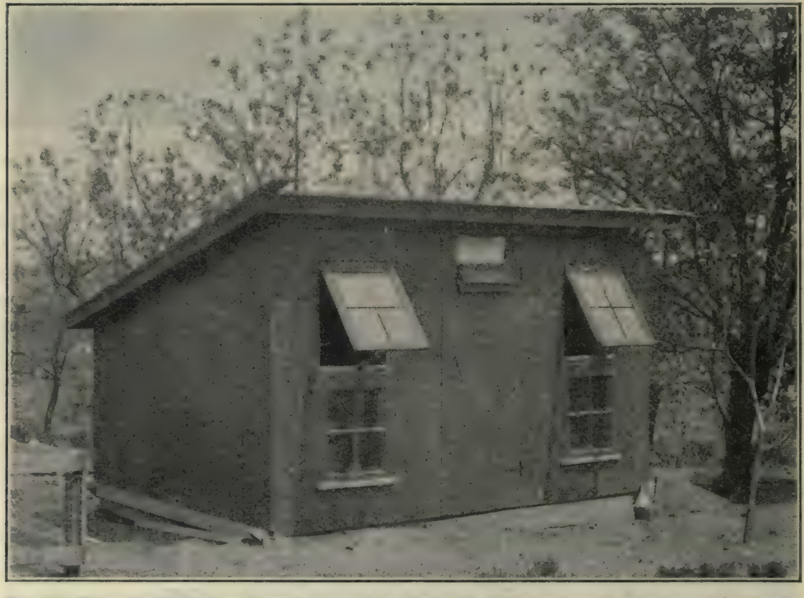

FIG. 10.—Stove-heated colony brooder houses are becoming more common on successful 160-acre farms in central Indiana

Most of the successful farmers use incubators rather than hens for hatching, although a few buy baby chicks, and stove-heated colony brooder houses are becoming more popular (Figure 10 and Purdue Extension Bulletin No. 52). These farmers realize the value of having chicks hatched in March or April to produce pullets for egg production the following winter and to permit getting the broilers on the early market when prices are favorable. Laying houses have improved in recent years. Some of the houses are well lighted, well ventilated, free from drafts, easy to clean and disinfect, and convenient for chores (Figure 11 and Purdue Experiment Station Circular No. 98).

Many of the successful farmers closely follow the feeding practices recommended by Purdue University, giving in self-feeders a mash of 50 parts bran, 50 parts middlings, and 30 parts 60 per cent tankage, and feeding a grain mixture of 100 parts corn, 100 parts wheat, and 50 parts oats. The grain is fed at the rate of 3 pounds of grain to 1 pound of mash from the time the hens are housed until January, when the proportion of grain to mash is gradually reduced until about equal quantities are fed by September. (See Purdue Experiment Station Circular No. 101.)

MILK COWS

Sales of dairy products have contributed an average of $209 per farm per year on the four most successful farms in the Clinton County group, in addition to the production of calves and approximately 600 gallons of milk, or its equivalent in butter and cream, and a quarter of beef for family consumption.

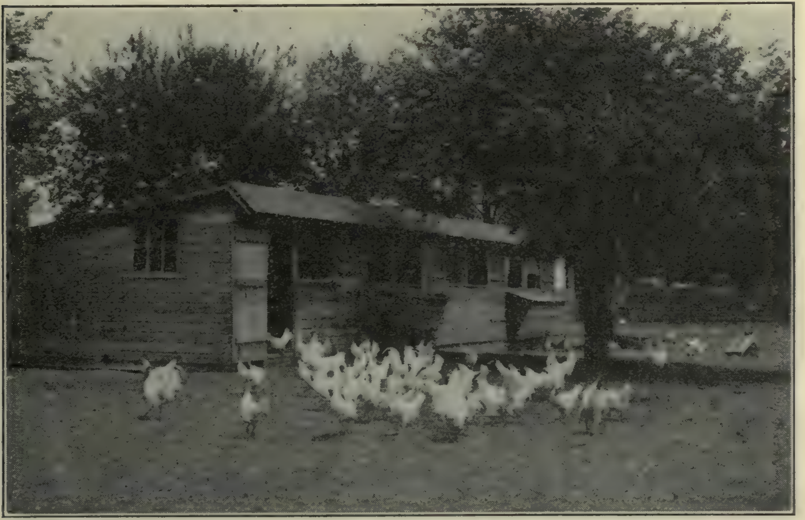

FIG. 11.—Some of the poultry houses on 160-acre farms are well lighted, well ventilated, free from drafts, easy to clean and disinfect, and convenient for chores. This house, 40 feet by 20 feet, accommodates 200 hens

From three to six milk cows, varying from the distinct dairy type to a dual-purpose type, have been kept on most of the successful farms where the hog type of farming is followed. The period of agricultural depression beginning in 1920 marked a considerable increase in the number of milk cows.

On many of the successful 160-acre farms, particularly where cattle are not kept in large enough numbers to form either an important beef or dairy enterprise, good big cows are kept that will produce from 100 to 150 pounds of butterfat per year and at the same time produce a high-class veal calf or a calf that will grow into a medium steer. The larger percentage are grade cows, although the so-called dual-purpose breeds find a place in this system. The owners of these farms justify the acceptance of this low production on the ground that such cows produce plenty of milk for home use and some surplus for sale, and that their calves are more valuable for veal than dairy calves and the cows are of greater market value for meat.

This system shades into the hog system and differs from it only in that some of the hogs in the hog system have been replaced by grade beef cows.

SHEEP

There were about one-third of a million sheep on the 98,000 farms included within the shaded portion of the map in Figure 1, but they enter into the organization of only a small percentage of the farms in central Indiana. They have been profitable on a number of the farms, and with the present prices of mutton and wool it would seem that some sheep might well be worked into the organization of more of the farms, especially on farms where hogs do not essentially predominate.

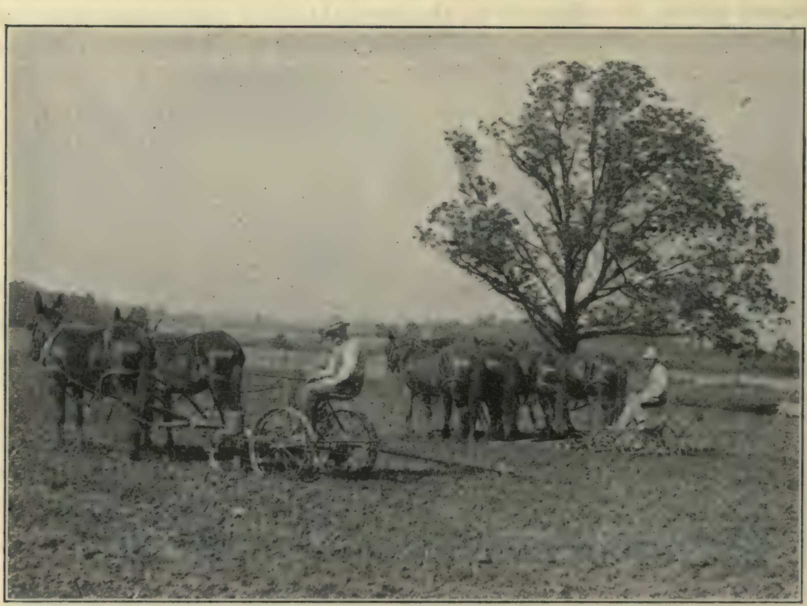

FIG. 12.—The work animals for a 160-acre farm in central Indiana

WORK ANIMALS

From six to eight horses are usually found on the 160-acre farms, six being the most common number on the more successful farms (fig. 12). With six 1,400 to 1,500 pound horses any of the ordinary machinery required on 160 acres can be used in such combinations that two outfits of three or less horses each or one outfit of four horses and one of two can be kept going during the rush season. Some of the good farmers justify the keeping of more than six horses by raising colts to sell or to replace the older horses (fig. 13).

TRACTOR

Successful men vary in opinion as to the economy of the tractor on 160-acre farms. With the ordinary system of farming in central Indiana, it is probably economical for a man to use a tractor if he is a good mechanic, if he likes to work with a tractor, and if he does not have to depend on different hired laborers to operate it. By using a tractor he can reduce the number of work animals to four. Men who are not naturally "tractor minded" and like horses, or who have to depend on transient hired help to operate the tractor, will do better with the horses. (See U. S. Department of Agriculture Farmers' Bulletins 1295 to 1300.)

MAN LABOR

The 160-acre farms are of the "two-man" size. The average of the four most successful farms in Clinton County required 25 months of man labor during the year. This labor is usually supplied by the operator with a hired man, by the father and one or more sons, by two brothers, or by partners, with occasional day labor hired in grain harvesting, haying, or corn husking. This size of business permits the employment of a man the year around, and this practice usually results in more satisfactory help than when employment can be offered only a part of the year (fig. 14).

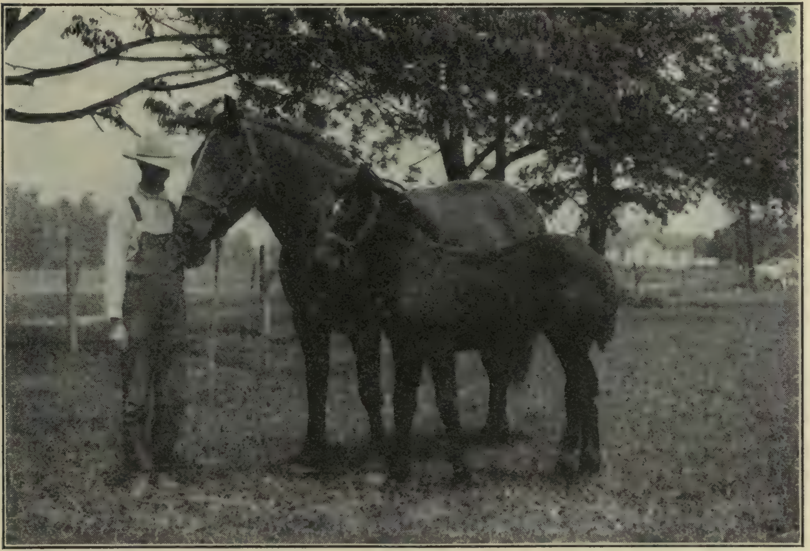

FIG. 13.—A work animal and a brood mare. This successful 160-acre farm furnishes its own work animals and $1,445 worth of horses weres old in eight years

MACHINERY

The most successful farms are equipped with better machinery of a higher type than the least successful ones. Farms as large as 160 acres can afford better machinery than smaller farms, and even with the same kind of machinery the cost per acre is lessened. A binder, for example, will last almost as many years when cutting the grain on a 160-acre farm as on an 80-acre farm. However, it is the judgment of the successful farmers that a 160-acre farm may easily be overequipped.

The machinery equipment for a 160-acre farm requires careful consideration. The list in Table 7 has been prepared after considering the machinery actually used on 160-acre farms, and interviewing several of the more successful 160-acre farmers.

FIG. 14.—An attractive tenant house helps to get and keep hired labor

TABLE 7.—*Suggested list of machinery for 160-acre farms in central Indiana*

Number	Kind	Size	Horses required
1	Walking plow	14 or 16 inches	3
1	Sulky plow [1]	do	2 to 4
1	Tandem disk	7 feet	4 to 6
1	Spike-tooth harrow	3-section	2 to 4
1	Tandem packer	8 feet	2 to 4
1	Corn planter (with fertilizer and soy-bean attachment)	2-row	2
1	Corn cultivator	do	3
1	do	1-row	2
1	Wheat drill (with fertilizer attachment)		2 to 4
1	Wheat drill if land in corn is seeded to wheat (with fertilizer attachment).		1
1	Grain binder	6 or 8 feet	3 to 4
2	Wagons		2
1	Mower	5 or 6 feet	2
1	Hay rake	10 or 12 feet	2
1	Hay loader		3
1	Hay tedder		2
1	Manure spreader	50 to 75 bushels	2 to 3
1	Walking cultivator		1
6	Work harnesses		
	Gasoline engine	1½ to 6 horsepower	
	Corn sheller—hand		
	Incubator		
	Cream separator		
	Miscellaneous small tools		

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[1] If the soil is of a type that is easily worked, a 14-inch gang plow is preferable to the sulky.

In connection with this list, it should be stated that some farmers are using such items of equipment as corn binders and silage cutters jointly with neighbors. The machines are owned jointly or one farm owns one machine and another farm owns another, thus reducing the capital-requirement, depreciation, and repair figures for each farm. Arrangements of this sort are economical when the machines can be used on more than one farm without loss of the crops on any of the farms. Some 160-acre farmers have occasionally bought second-hand machinery that they would not have been justified in buying new. Proper sheltering of machinery is an important consideration in reducing depreciation. (Fig. 15).

Successful 160-acre farmers as a rule have an automobile which has sometimes replaced a horse and buggy and driving harness. It often accounts for greater efficiency in the operation of the farm and adds to the pleasure of the farmer and his family.

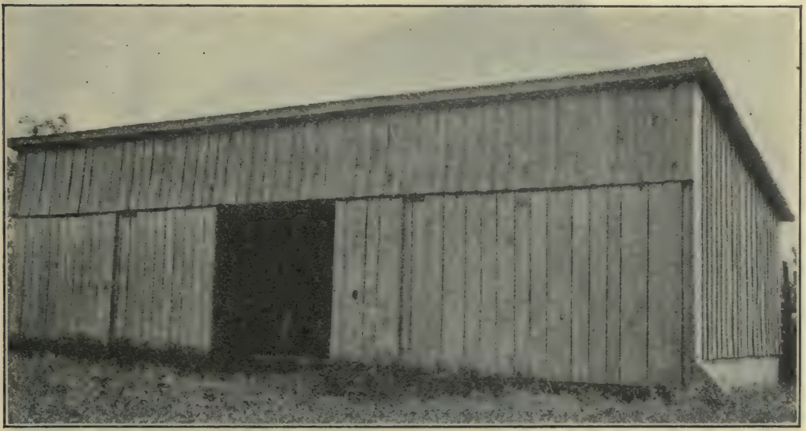


FIG. 15.—This type of building used for sheltering machinery when not in use is not expensive and makes the machinery last longer

IMPROVEMENTS

A large number of 160-acre farms were made this size by the union of two or more smaller farms or by the division of a larger farm, after many of the buildings were already erected. Frequently in such cases the buildings are either inadequate or too expensive for the farm. Buildings erected by a former owner of the farm for a particular system of farming often do not suit the system followed by the present owner. Buildings represent approximately 9 per cent of the capital on 160-acre farms. Repair and depreciation charges, an important item of expense, average $87 per year in the Clinton County area. Adequacy of buildings and convenience of their arrangement has an important influence on the time required for chores, the returns that can be secured from livestock, and the selling value of the farm. Buildings, therefore, deserve careful consideration.

On most of the successful 160-acre farms there is not an over-capitalization in buildings. Fancy buildings are not necessary for good profits. Too great an investment in buildings results in excessive interest, depreciation, and repair costs. The most desirable buildings are simple, economically constructed, well-planned and neat in appearance. (See figs. 10, 11, 14, 15, 16, 17, 18, 20.)

There are usually from 1,000 to 1,300 rods of permanent fence on the average 160-acre farm in central Indiana. Some of this is rail but most of it is woven wire. The interest, depreciation, and repairs on this item amounting ordinarily to $1 to $1.50 per acre per year, must be borne by the crops and livestock. This expense can be reduced by good farm layout. A few men are reducing the amount of fencing by using permanent fences only around the outside of the farm and around permanent pasture, and stretching temporary fence around rotation pasture. This practice prevents the use of livestock in turning into profits the aftergrowths and unharvested crops on the various fields, and is therefore of doubtful economy. Temporary fence is often used to advantage, however, in fencing off a part of a field of corn for "hogging off" or in separating a clover field for hay and for pasture.

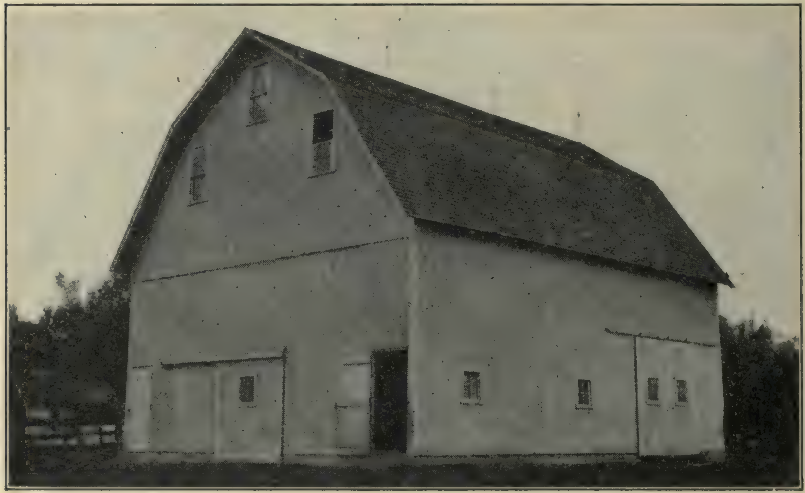


FIG. 16.—A good barn on a 160-acre "hog" farm. It is 60 feet by 40 feet and 20 feet to the eaves. There is room for 6 horses, 4 to 6 cows, and some young cattle. It has mow space for 20 or more tons of hay and bins for 1,000 or more bushels of grain

Most of the land in central Indiana is already well tiled. Although tiling considerably increases the cost per acre of land it is a profitable investment.

THE HOG AND BEEF CATTLE FEEDING SYSTEM

An important variation from the hog system on successful 160-acre farms is the system that includes the feeding of beef cattle usually in quantities sufficient to make either one or two carloads (20 or 40 head). Under this system, cattle feeding has the same advantage as dairying in regard to consumption of larger quantities of roughages in proportion to corn than is possible with straight hog farming.

Sometimes at least a part of the cattle are raised on the farm where they are fed, but the more common practice on the successful 160-acre hog and beef cattle farms is to purchase the cattle from stockyards. Occasionally they are picked up from neighboring farms, but this practice does not provide cattle of uniform type. The length of time the cattle may be most economically fed depends on their age, weight, and condition, and the economic conditions prevailing at the time. Cattle 2 years old or over that carry considerable flesh are usually fed more profitably for a short period of not over 90 days than for a longer period. The most successful practice with young cattle of good quality usually is to feed them until they are "finished." From 2 to 2½ pounds of protein supplement, such as oil meal, cottonseed meal, or soy-bean meal, per 1,000 pounds live weight, are given in addition to silage, hay, and corn during the time the cattle are on full feed. Hogs are usually run behind the cattle, especially if the corn fed is not ground or shelled and older cattle are being fed.

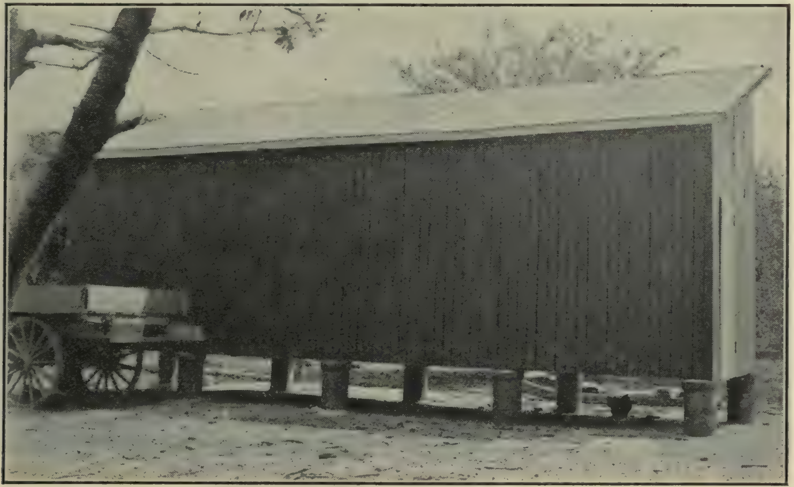


FIG. 17.—The corncrib on one of the successful 160-acre farms in Clinton County

Some men follow a hog and beef system in which beef cows are kept to raise calves for sale at various ages, either as breeding stock or as feeders, but do not feed out cattle in quantities.

Crop rotation, machinery, work animals, and labor requirements for the hog and beef cattle system do not differ materially from those for the hog system. An open shed with cement floor, an inclosed lot, feed racks and bunks, and usually a silo (fig. 18), with the consequent ownership of a whole or a part of a corn binder and ensilage cutter, are the most important equipment needed in addition to that on hog farms.

THE HOG AND DAIRY SYSTEM

In the hog and dairy system much the same rotation crops are grown by the successful men, with a tendency to decrease the amount of timothy seeding in the clover and occasionally to grow alfalfa on account of the value of straight legume hay as a dairy feed Successful dairying on a large scale on 160-acre farms in the past has usually been either the result of a fairly large amount of rough or rolling land more suited to pasture than crop production or of a particularly good market for dairy products, as a retail trade in town or city. From 1920 to 1925, however, there has been some expansion in dairying on 160-acre farms, as on farms of other sizes in central Indiana (fig. 19).

On dairy farms where cream rather than whole milk is sold, the skim milk available greatly reduces the amount of tankage necessary to buy for hogs and poultry. With the smaller number of hogs and increased number of cattle, there is a somewhat better adjustment of feed to livestock requirements, as the dairy cows are not as heavy consumers of corn in proportion to roughage as hogs; and in the hog system, when sufficient legume is given to maintain fertility economically, there is usually an abundance of roughage as compared with corn.

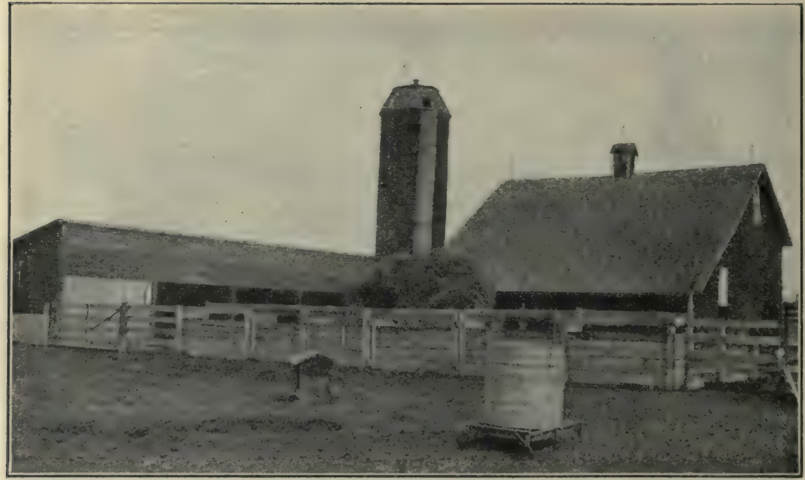


FIG. 18.—A good type of cattle-feeding plant

The feed available on the ordinary 160-acre farms in central Indiana forms the foundation for a good dairy ration. A silo is not usually considered economical with the small number of cows on the farms following the hog system, but is advisable where 10 or more cows are kept. With the good clover hay available on many of these farms, the grain ration recommended by Purdue University consisting of 400 parts by weight of ground corn, 200 parts ground oats or bran, and 100 parts linseed meal or soy-bean meal, fed at the rate of 1 pound per day for each 3 pounds of Jersey and Guernsey milk, and for each 4 pounds of Holstein and Ayrshire milk, produces good results for winter feeding. When the dry roughage fed is part legume hay and part timothy hay or corn stalks, a grain mixture of 400 parts corn, 300 parts ground oats or bran, and 200 parts linseed meal or soy-bean meal produces better results. Many of the successful farmers feed no grain when the cows are on the good pasture of these farms at favorable seasons, although with the higher-producing cows and particularly when pasture is scarce or dry about half of the winter grain ration is fed and at times some legume hay is given.

Some of the more successful dairymen are feeding silage at the rate of approximately 30 pounds per day and good legume hay at the rate of about 10 pounds per 1,000 pounds of cow in addition to the grain ration.

The machinery and work animals on the successful 160-acre dairy farms differ very little from that already described for the hog farms. When there is a silo, most men own a corn binder or a share in one and usually have a share in a silage cutter.

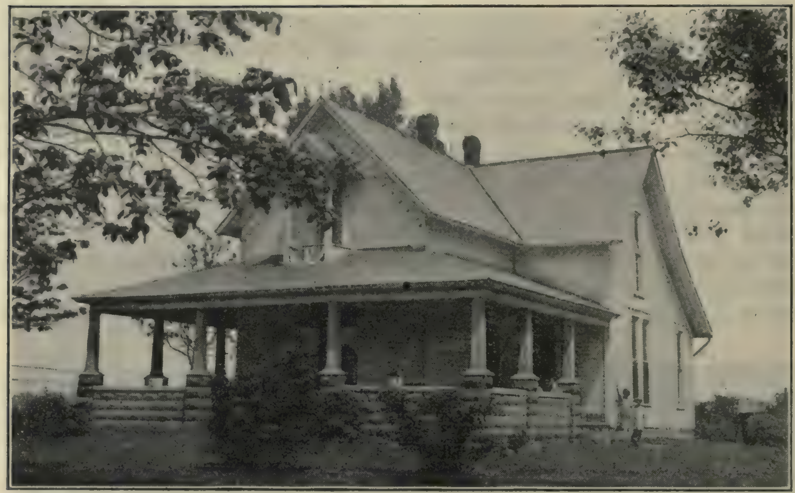
Because man labor constitutes a relatively higher proportion of the cost of producing dairy products than of producing hogs, the dairy system requires some more man labor. With hand milking, ordinarily as much time is spent on a good dairy cow in central Indiana during a year as is required to care for two brood sows and their litters or to raise 5 acres of corn. But, while milking cuts down the time available for field work in summer, it makes a market for winter labor and two men can operate a hog and dairy farm with 10 or more cows and almost as many sows as under the hog system.

FIG. 19.—A herd of good dairy cows

FARM ACCOUNTS

Many of the successful farmers recognize the fact that simple records are becoming almost a necessity in the successful operation of their farm business. Farm records are valuable in many ways, but their most important use is in helping the farmer discover the weaknesses in his farm business.

One farmer in central Indiana found, the first year he kept accounts, that his farm compared favorably with other farms in his community in size of business, crop yields, use of labor, and other important factors, except in returns from his livestock. He was getting only



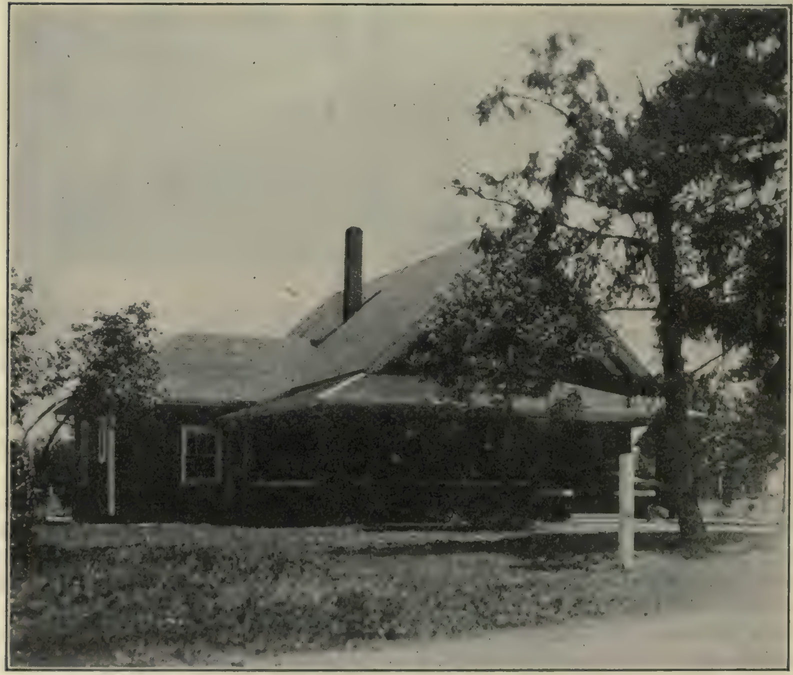


FIG. 20.—The homes of two of the successful 160-acre farms in central Indiana.

$1.01 from his livestock for each $1 worth of feed, which was not enough to pay for other costs such as labor, shelter, interest, and taxes. The record showed that he did not have protein to make a balanced feed for his livestock. He had been feeding his hogs almost entirely on corn. The next year he bought tankage and other protein concentrates to make a balanced ration. His returns from livestock and consequently his labor income showed a decided increase that year. He has declared he will continue to keep records as "long as he has two eyes." Any 160-acre farmer who keeps simple accounts will be able to compare his results with the standards given in Table 8 in the back of this bulletin and then determine where his attention is needed in improving his business.

An inventory of all livestock, feeds, machinery, and other property taken once a year, together with a financial record of the farm receipts and expenses during the year, is considered the most useful account. The farm account book issued by the agricultural extension department of Purdue University, which provides for accounts of this kind, is used by many of the successful men. Similar practical account books can be obtained at cost from the agricultural colleges in most of the States.

SUCCESSFUL FARMING AND GOOD LIVING

Financially successful 160-acre farmers are generally wise spenders. Some have comfortable and attractive houses with modern conveniences, including electric lights, running water, bathrooms, and furnaces (fig. 20). Some of the houses with electricity or other power use it for separating cream and making butter, for laundry work, or for house cleaning. It is the opinion of these owners that the money expended for such improvements is a wise investment. Many of the more successful farmers, from the financial standpoint, are the most interested in those things that result in a higher standard of living in the farm homes. Their boys and girls are participating in club work and are given educational opportunities.

STANDARDS OF ORGANIZATION AND MANAGEMENT

Table 8, showing the standards in farm organization and management under the hog system, the hog and cattle feeding system, and the hog and dairy system is given for the guidance of 160-acre farmers in central Indiana and similar adjacent areas. It is fully realized that conditions differ from farm to farm and that no two farms are exactly alike in every respect. The standards should be interpreted as subject to modifications to meet the conditions existing on each farm. Some modifications have been discussed. To farmers on 160-acre farms who maintain standards as high as those in Table 8, over a period of several years, success is almost certain.

TABLE 8.—*Standards of organization and management for successful farming on 160-acre farms*

	Hog system	Hog and cattle feeding system	Hog and dairy system	Your own system
Land:				
Farmstead, roads, lanes, etc. ... acres	7	7	7	----------
Permanent pasture ... do	15	15	15	----------
Rotation land ... do	138	138	138	----------
Corn for grain ... do	46	39	41	----------
Corn for silage ... do	----------	7	5	----------
Wheat ... do	23	23	23	----------
Oats ... do	23	23	23	----------
Hay, clover or mixed ... do	13	12	15	----------
Rotation pasture ... do	33	34	31	----------
Yields per acre:				
Corn for grain ... bushels	50	50	50	----------
Corn for silage ... tons	----------	10	10	----------
Wheat ... bushels	20	20	20	----------
Oats ... do	45	45	45	----------
Hay, clover or mixed ... tons	1.5	1.5	1.5	----------
Crop production:				
Corn for grain ... bushels	2,300	1,950	2,050	----------
Corn for silage ... tons	----------	70	50	----------
Wheat ... bushels	460	460	460	----------
Oats ... do	1,035	1,035	1,035	----------
Hay, clover or mixed ... tons	20	18	23	----------
Livestock:				
Sows ... number	15	10	8	----------
Boars ... do	1	1	1	----------
Dairy cows ... do	4	4	15	----------
Young cattle ... do	2	2	6	----------
Bull ... do	----------	----------	1	----------
Or—				
Dual-purpose cows ... do	5	5	----------	----------
Young cattle ... do	2	2	----------	----------
Bull ... do	1	1	----------	----------
Feeding cattle ... do	----------	20	----------	----------
Work animals ... do	6	6	6	----------
Hens ... do	200	200	200	----------
Livestock production per animal:				
Sow, pigs to 225 pounds weight ... do	9	9	9	
Dairy cows—				
Whole milk ... pounds	6,000	6,000	6,000	----------
Butterfat ... do	275	275	275	----------
Calves ... number	.8	.8	.8	----------
Dual-purpose cows—				
Whole milk ... pounds	4,000	4,000	----------	----------
Butterfat ... do	170	170	----------	----------
Calves ... number	.8	.8	----------	----------
Feeding cattle, gain in 120 days ... pounds	----------	275	----------	----------
Hens, eggs ... dozen	9.5	9.5	9.5	----------
Livestock production:				
Sows, pigs to 225 pounds weight ... number	135	90	72	----------
Dairy cows—				
Whole milk ... pounds	24,000	24,000	90,000	----------
Butterfat ... do	1,100	1,100	4,125	----------
Calves ... number	3	3	12	----------
Or—				
Dual-purpose cows—				
Whole milk ... pounds	20,000	20,000	----------	----------
Butterfat ... do	850	850	----------	----------
Calves ... number	4	4	----------	----------
Feeding cattle, gain in 120 days ... pounds	----------	5,500	----------	----------
Hens, eggs ... dozen	1,900	1,900	1,900	----------
Chicks raised ... number	300	300	300	----------
Colts raised ... do	1	1	1	----------
Approximate feed requirements:				
Sows and boar—				
Corn (25 bushels per head) ... bushels	400	275	225	----------
Tankage (100 pounds per head) ... pounds	1,600	1,100	900	----------
Hogs, from weaning to 225 pounds weight—				
Corn (15 bushels per head) ... bushels	2,025	1,350	1,080	----------
Tankage ... pounds	8,100	5,400	1,828	----------
Skim milk (substituted for tankage, 13 pounds skim milk equals 1 pound tankage) ... pounds	----------	----------	32,400	----------
Dairy bull—				
Corn ... bushels	----------	----------	12	----------
Oats ... do	----------	----------	10	----------
Oil meal or cottonseed meal ... pounds	----------	----------	170	----------
Hay (2 tons without silage or 1 ton with silage) ... tons	----------	----------	1	----------
Silage ... do	----------	----------	3	----------

TABLE 8.—*Standards of organization and management for successful farming on 160-acre farms*—Continued

	Hog system	Hog and cattle feeding system	Hog and dairy system	Your own system
Approximate feed requirements—Continued.				
Dairy cows—				
Corn (20 bushels per head) bushels	80	80	300	----------
Oats (18 bushels per head) do	72	72	270	----------
Oil meal or cottonseed meal (281 pounds per head) pounds	1,125	1,125	4,215	----------
Hay (1.5 tons per head without silage or 0.6 ton with silage) tons	6	2.4	9	----------
Silage do	----------	10.8	40.5	----------
Young dairy cattle—				
Veal calves, to 6 weeks old—				
Corn (20 pounds per head) bushels	.7	.7	3.2	----------
Oats (10 pounds per head) do	.6	.6	3	----------
Bran (10 pounds per head) pounds	20	20	90	----------
Oil meal (5 pounds per head) do	10	10	45	----------
Whole milk (125 pounds per head) do	250	250	1,125	----------
Skim milk (400 pounds per head) do	800	800	3,600	----------
Hay (30 pounds per head) tons	.03	.03	.14	----------
Heifers, to 1 year old—				
Corn (8 bushels per head) bushels	8	8	24	----------
Oats (7 bushels per head) do	7	7	21	----------
Oil meal or cotton seed meal (100 pounds per head) pounds	100	100	300	----------
Whole milk (200 pounds per head do	200	200	600	----------
Skim milk (2,000 pounds per head) do	2,000	2,000	6,000	----------
Hay (0.7 ton per head without silage or 0.5 ton with silage) tons	.7	.5	1.5	----------
Silage do	----------	.5	1.5	----------
Heifers, from 1 to 2 years old—				
Corn (6 bushels per head) bushels	6	6	18	----------
Oats (5 bushels per head) do	5	5	15	----------
Oil meal or cottonseed meal pounds	85	85	255	----------
Hay (1.5 tons per head without silage or 1 ton with silage) tons	1.5	1.0	3	----------
Silage (1.5 tons per head) do	----------	1.5	4.5	----------
Dual-purpose bull—				
Corn bushels	8	8	----------	----------
Oats do	6	6	----------	----------
Oil meal or cottonseed meal pounds	100	100	----------	----------
Hay (1.5 tons without silage or 1 ton with silage) tons	1.5	1	----------	----------
Silage do	----------	1.5	----------	----------
Dual-purpose cows—				
Corn (8 bushels per head) bushels	40	40	----------	----------
Oats (6 bushels per head) do	30	30	----------	----------
Oil meal or cottonseed meal (100 pounds per head) pounds	500	500	----------	----------
Hay (1.5 tons per head without silage or 0.6 ton with silage) tons	7.5	3	----------	----------
Silage do	----------	13.5	----------	----------
Young dual-purpose cattle—				
Veal calves, to 6 weeks old—				
Corn (20 pounds per head) bushels	1	1	----------	----------
Oats (10 pounds per head) do	1	1	----------	----------
Bran (10 pounds per head) pounds	30	30	----------	----------
Oil meal (5 pounds per head) do	15	15	----------	----------
Whole milk (125 pounds per head) do	375	375	----------	----------
Skim milk (400 pounds per head) do	1,200	1,200	----------	----------
Hay (30 pounds per head) tons	.04	.04	----------	----------
Calves, to 1 year old—				
Corn (8 bushels per head) bushels	8	8	----------	----------
Oats (7 bushels per head) do	7	7	----------	----------
Oil meal or cottonseed meal (100 pounds per head) pounds	100	100	----------	----------
Whole milk (200 pounds per head) do	200	200	----------	----------
Skim milk (2,000 pounds per head) do	2,000	2,000	----------	----------
Hay (0.7 ton per head without silage or 0.5 ton with silage) tons	.7	.5	----------	----------
Silage (0.5 ton per head) do	----------	.5	----------	----------
Yearlings, from 1 to 2 years old—				
Corn (6 bushels per head) bushels	6	6	----------	----------
Oats (5 bushels per head) do	5	5	----------	----------
Oil meal or cottonseed meal (85 pounds per head) pounds	85	85	----------	----------
Hay (1.5 tons per head without silage or 1 ton with silage) tons	1.5	1	----------	----------
Silage (1.5 tons per head) do	----------	1.5	----------	----------

TABLE 8.—*Standards of organization and management for successful farming on 160-acre farms*—Continued

	Hog system	Hog and cattle feeding system	Hog and dairy system	Your own system
Approximate feed requirements—Continued.				
Feeding cattle—from 850 to 1,125 pounds weight—				
Corn (22½ bushels per head in 120 days) ... bushels		450		
Cottonseed meal (143 pounds per head in 120 days) tons		1. 43		
Hay (0.2 ton per head with silage) ... do		4		
Silage (2.6 tons per head in 120 days) ... do		52		
Work animals—				
Corn (43 bushels per head) ... bushels	258	258	258	
Oats (25 bushels per head) ... do	150	150	150	
Hay (1 ton per head) ... tons	6	6	6	
Fodder or straw (500 pounds per head) ... do	1. 5	1. 5	1. 5	
Colts, to 1 year old—				
Corn ... bushels	6	6	6	
Oats ... do	11	11	11	
Bran ... pounds	350	350	350	
Hay ... tons	. 6	. 6	. 6	
Fodder or straw ... do	. 2	. 2	. 2	
Colts, from 1 to 2 years old—				
Corn ... bushels	9	9	9	
Oats ... do	16	16	16	
Bran ... pounds	500	500	500	
Hay ... tons	. 9	. 9	. 9	
Fodder or straw ... do	. 2	. 2	. 2	
Colts, 2 to 3 years old—				
Corn ... bushels	9	9	9	
Oats ... do	31	31	31	
Bran ... pounds	500	500	500	
Hay ... tons	1	1	1	
Fodder or straw ... do	. 2	. 2	. 2	
Hens—				
Corn (43 bushels per 100 head) ... bushels	86	86	86	
Oats (38 bushels per 100 head) ... do	76	76	76	
Wheat (40 bushels per 100 head) ... do	80	80	80	
Bran (1,200 pounds per 100 head) ... pounds	2, 400	2, 400	2, 400	
Shorts (1,200 pounds per 100 head) ... do	2, 400	2, 400	2, 400	
Skim milk ... do	3, 900	3, 900	24, 000	
Tankage (substitute for skim milk, 1 pound tankage equals 13 pounds skim milk) ... do	1, 546	1, 546		
Young chickens—				
Corn (10 bushels per 100 head) ... bushels	30	30	30	
Bran (220 pounds per 100 head) ... pounds	660	660	660	
Shorts (220 pounds per 100 head) ... do	660	660	660	
Skim milk (1,800 pounds per 100 head) ... do	5, 400	5, 400	5, 400	
Summary of feed for all livestock:				
Corn ... bushels	2, 886	2, 536	2, 060	
Silage ... tons		69	50	
Wheat ... bushels	80	80	80	
Oats ... do	343	333	603	
Hay ... tons	20	18	23	
Whole milk ... pounds	575	575	1, 725	
Skim milk ... do	12, 500	12, 500	71, 400	
Tankage ... do	11, 246	8, 046	2, 728	
Oil meal and cottonseed meal ... do	800	3, 660	4, 925	
Bran and shorts ... do	7, 500	7, 500	7, 560	
Probable products for sale:				
Corn ... bushels				
Wheat ... do	345	345	345	
Oats ... do	630	640	370	
Hay ... tons				
Boar ... number	1	1	1	
Sows ... do	5	3	3	
Other hogs, at 225 pounds weight ... do	123	80	62	
Cows ... do	1	1	3	
Veal calves ... do	2	2	9	
Fat cattle at 1,125 pounds weight ... do		20		
Whole milk ... pounds	14, 700	14, 700	84, 050	
Or—				
Butter fat ... do	625	625	2, 092	
Hens ... number	70	70	70	
Broilers ... do	60	60	60	
Eggs ... dozen	1, 670	1, 670	1, 670	
Horses ... number	1	1	1	
Products for family use:				
Orchard, garden, etc ... acres	1. 5	1. 5	1. 5	
Hogs ... number	7	7	7	
Beef ... "quarters"	1	1	1	
Dairy products, butterfat equivalent ... pounds	200	200	200	
Chickens ... number	100	100	100	
Eggs ... dozen	165	165	165	
Firewood ... cords	11	11	11	

TABLE 8.—*Standards of organization and management for successful farming on 160-acre farms*—Continued

	Hog system	Hog and cattle feeding system	Hog and dairy system	Your own system
Probable items of expense:				
Feed purchased—				
Corn .... bushels	600	586	----------	----------
Oil meal and cottonseed meal .... pounds	800	3, 660	4, 925	----------
Bran and shorts .... do	7, 500	7, 500	7, 560	----------
Tankage .... do	11, 246	8, 046	2, 728	----------
Salt .... barrels	2	2	2	----------
Labor, hired man, son, or partner .... months	12	12	12	----------
Extra, family or hired .... do	1	1	2	----------
Fertilizer (200 pounds per acre on wheat) .... pounds	4, 600	4, 600	4, 600	----------
Livestock—				
Boar .... number	1	1	1	----------
Feeding steers (at 850 pounds weight) .... do	----------	20	----------	----------
Seeds purchased—				
Clover (1 bushel to 8 acres) .... bushels	6	6	6	----------
Timothy (1 bushel to 6 acres) .... do	8	8	8	----------
Soy beans (1 bushel to 12 acres planted with corn) .... do	4	4	4	----------
Vaccination for hog cholera (one treatment for each animal) .... number	151	101	81	----------
Machine work hired—				
Threshing wheat .... bushels	460	460	460	----------
Threshing oats .... do	1, 035	1, 035	1, 035	----------
Feed grinding	----------	----------	----------	----------
Baling	----------	----------	----------	----------
Repairs—				
Houses .... per cent of value	1	1	1	----------
Other buildings .... do	1	1	1	----------
Fences .... do	----------	----------	----------	----------
Machinery .... do	2. 5	2. 5	2. 5	----------
Depreciation—				
Houses .... do	1. 5	1. 5	1. 5	----------
Other buildings .... do	2	2	2	----------
Machinery .... do	9	9	9	----------
Insurance	----------	----------	----------	----------
Taxes	----------	----------	----------	----------
Other farm expenses	----------	----------	----------	----------

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July 14, 1925

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1464

BARLEY

CULTURE USES AND VARIETIES

1862 1889

BARLEY should be more widely grown in the Northern and Western States. It is an excellent grain feed for stock, being almost the equal of corn. It, however, competes with corn in few places, as it is mostly grown outside the limits of profitable corn culture. It produces more pounds to the acre than oats or wheat. If necessary, it can be seeded later than spring wheat and hence interferes little with the wheat acreage in the spring-wheat region. It supplies the needed grain feed necessary for the increase of livestock, which sometime must come with diversified farming in the areas where grain farming is now the only enterprise.

The best lands for barley are well-drained soils that are not sandy. The best returns are obtained from early seeding. The best methods of preparation are fall plowing in the humid-spring region, disked corn ground on the Great Plains, and summer fallow in sections where the crop is winter seeded. The best method of seeding is with a drill, and the best method of harvesting is with a binder. The grain should not be threshed too close, as broken kernels lower the market value.

The best-yielding varieties are Tennessee Winter in the humid-winter region, Manchuria and Oderbrucker in the humid-spring region, and Coast, Hannchen, Club Mariout, White Smyrna, Chevalier, and Trebi in the semiarid region.

This bulletin is a revision of and supersedes Farmers' Bulletin 968, Cultivation and Utilization of Barley.

Washington, D. C. **Issued October, 1925**

BARLEY: CULTURE, USES, AND VARIETIES

By HARRY V. HARLAN, *Agronomist in Charge of Barley Investigations, Office of Cereal Investigations, Bureau of Plant Industry*

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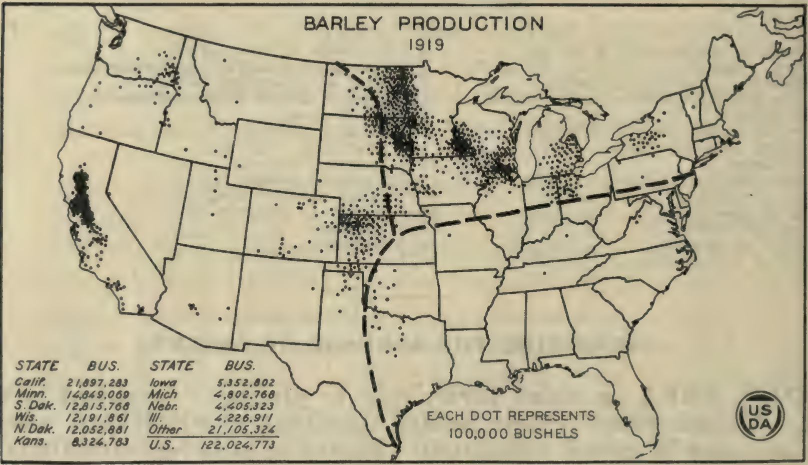
INCREASING THE ACREAGE OF BARLEY

THE AREA on which barley may be profitably produced in the United States is more limited than that on which corn, wheat, or oats may be grown with profit. Barley is, however, exceptionally well suited to certain sections, and in these sections is a very profitable crop. Its worth is not realized in some localities well suited to its culture. In the West its crop value is appreciated, but throughout the Northern States east of the Rocky Mountains the acreage under cultivation is far too small. In these States it is sound economics to increase the barley acreage for the purpose of producing feed for livestock. Before the law prohibiting the manufacture of beer containing more than a very small percentage of alcohol was enacted the best grades of barley went to the malt houses and only inferior grain remained on the farm to be fed. This prevented the farmers of the Mississippi Valley from realizing its full value as a feed. Even now the quantity of feed produced per acre is not appreciated by the average farmer. The acreage for stock feed could be greatly extended without prejudice to, and indeed to the advantage of, the remaining maltsters, as there would be a larger offering from which they might choose.

This publication is intended to give a brief statement of the barley areas and the culture and uses of the crop in such a way as to enable the farmer to decide whether or not it is to his individual advantage to grow barley on his farm.

BARLEY REGIONS

As shown on the accompanying map (fig. 1), the United States may be divided into three general climatic regions, which divisions differ in their economic, varietal, and cultural aspects as well as their climatic features. These will be designated as the semiarid, the humid-spring, and the humid-winter regions. In the semiarid region the period from flowering to ripening is one of scanty rainfall and a very dry atmosphere. In the humid-spring region the same period is marked by frequent summer rains and a humid atmosphere. The humid-winter region is similar to the humid-spring, except that the barley is fall sown. In the semiarid region, the California crop is winter sown, whereas in the States to the north and east of California it is spring sown.



STATE	BUS.	STATE	BUS.
Calif.	21,897,283	Iowa	5,352,802
Minn.	14,849,069	Mich	4,802,768
S. Dak.	12,815,768	Nebr.	4,405,323
Wis.	12,191,861	Ill.	4,226,911
N. Dak.	12,052,881	Other	21,105,324
Kans.	8,324,783	U.S.	122,024,773

FIG. 1.—Outline map of the United States, showing the three general regions of barley production. The heavy broken lines divide the country into the humid-spring region (northeast), the humid-winter region (southeast), and the semiarid region (west). The dots show the production of barley, according to the census of 1920

It will be noted that the arid-humid line does not follow the line of rainfall in the North. This probably indicates a humidity-temperature factor. The southern Plains are much hotter than the northern, which would have a tendency to extend the humid belt in the North and contract it in the South. The line south of Nebraska is not a stable one. The culture of winter barley is increasing gradually in western Oklahoma and adjacent portions of the Texas Panhandle. At the same time the spring-barley acreage of Kansas is increasing. There is now an overlapping of the spring and winter culture in southwestern Kansas and western Oklahoma. The line separating the humid-spring from the humid-winter region is still arbitrary. Except on the Great Plains there is a wide belt between the northern limits of profitable winter-barley culture and the southern limits of profitable spring-barley culture in which barley is grown only in especially favored localities.

SPECIAL AREAS DUE TO CLIMATIC VARIATIONS

The three general regions are subdivided by variations in climate into areas of special characteristics.

In the two humid regions there are few local variations. In the South winter barley finds very favorable climatic conditions in the mountain areas, especially in eastern Tennessee. The total production, however, is insignificant. In the North some winter barley is produced in the neighborhood of the Great Lakes and in southern Ohio. In New York 2-rowed barleys can be grown with more comparative success than in the upper Mississippi Valley.

In the semiarid region there are many variations, as might be expected from the topography. The Great Plains constitute a subdivision almost equal in rank with the three regions themselves. This area, while of light rainfall, differs from the rest of the semiarid region in having a summer rainfall which modifies both the conditions of growth and the varieties grown. The entire northern Plains constitute a section especially suited to the culture of 2-rowed barleys. Hooded sorts are often grown on the southern Plains and in localities of high altitude in the Rocky Mountain region. Several counties in northwestern Kansas have a climate unusually favorable to barley production, and because it is relatively profitable the acreage is being expanded beyond these counties throughout the western part of the State, as shown in Figure 1.

The Great Basin has features peculiar to itself and distinct from California.

SPECIAL AREAS DUE TO SOIL VARIATIONS

A study of the map (fig. 1) shows that, even in the sections of greatest production where every climatic feature is favorable, there are localities where very little barley is grown and others where it is almost a predominating crop. This distribution is due to differences in soil.

Barley is very sensitive to soil variation. It demands a well-drained soil, but does not thrive on sands. The projection of barley production into less favorable climates is noticeable in the barley soils which lie along the Mississippi and Missouri Rivers. The effect of inadequate drainage is apparent in south-central Minnesota, an area favoring barley in climate, where, as shown in Figure 1, a poorly drained area separates the heavy-producing sections on either side. Oats give a higher average return than barley in this section. As a rule, soil variations affect the acreage of barley grown, but have little relation to the varieties sown or the methods of production.

ECONOMICS OF BARLEY GROWING

Barley is grown both as a cash crop and as feed. The percentage of the crop reaching the terminal markets is steadily decreasing. West of the hundredth meridian it is steadily increasing in importance as a feed grain. Wherever grown as a feed crop barley must compete with oats, in some cases with corn, and in very limited areas with wheat. For the most part, barley is grown north and west of the limits of profitable corn culture. Where corn can be profitably grown it gives higher feed returns than either oats or barley. On most farms, however, farm-management demands (either labor distribution or rotation requirements) necessitate at least one spring-sown small grain. Wheat, because of its use as a bread crop, has a market and a resulting cash return which is not determined by feed values. The only crop that can be compared readily with barley in farm economy is oats. Both are spring sown and both are feed crops, for the excess of barley over the malting demands must depend on animal consumption for its market.

TABLE 1.—*The average acreage and yields of barley and oats, with the calculation of protein, carbohydrates, and fat, in 33 States for the years 1922, 1923, and 1924*

States	Acreage		Yields per acre (pounds)							
			Grain		Digestible nutrients					
					Protein		Carbohydrates and fat (×2.25)		Total	
	Barley	Oats	Barley	Oats	Barley	Oats	Barley	Oats	Barley	Oats
Maine	4, 000	122, 000	1, 344	1, 194	121	116	946	725	1, 067	841
Vermont	9, 000	78, 000	1, 440	1, 142	130	111	1, 014	693	1, 143	804
New York	193, 000	1, 007, 000	1, 325	1, 046	119	101	933	635	1, 052	736
Pennsylvania	12, 000	1, 123, 000	1, 190	1, 056	107	102	838	641	945	743
Maryland	4, 000	59, 000	1, 598	1, 002	144	97	1, 125	608	1, 269	705
Virginia	10, 000	172, 000	1, 306	698	118	68	919	424	1, 037	491
Ohio	74, 000	1, 522, 000	1, 224	1, 094	110	106	862	664	972	770
Indiana	31, 000	1, 696, 000	1, 042	928	94	90	734	563	827	653
Illinois	223, 000	3, 937, 000	1, 430	1, 104	129	107	1, 007	670	1, 135	777
Michigan	148, 000	1, 542, 000	1, 291	1, 152	116	112	909	699	1, 025	811
Wisconsin	444, 000	2, 531, 000	1, 483	1, 254	133	122	1, 044	761	1, 178	883
Minnesota	928, 000	4, 240, 000	1, 334	1, 232	120	120	939	748	1, 059	867
Iowa	156, 000	5, 807, 000	1, 416	1, 242	127	120	997	754	1, 124	874
Missouri	5, 000	1, 366, 000	1, 200	730	108	71	845	443	953	514
North Dakota	1, 203, 000	2, 507, 000	1, 104	960	99	93	777	583	877	676
South Dakota	857, 000	2, 451, 000	1, 176	1, 088	106	106	828	660	934	766
Nebraska	277, 000	2, 440, 000	1, 138	931	102	90	801	565	904	655
Kansas	899, 000	1, 454, 000	898	752	81	73	632	456	713	529
Kentucky	6, 000	230, 000	1, 262	666	114	65	888	404	1, 002	469
Tennessee	16, 000	220, 000	1, 046	650	94	63	736	395	831	458
Texas	105, 000	1, 421, 000	1, 138	950	102	92	801	577	904	669
Oklahoma	148, 000	1, 380, 000	1, 022	714	92	69	719	433	811	503
Montana	107, 000	649, 000	1, 210	1, 008	109	98	852	612	961	710
Wyoming	26, 000	164, 000	1, 406	1, 024	127	99	990	622	1, 116	721
Colorado	275, 000	224, 000	1, 152	874	104	85	811	531	915	615
New Mexico	11, 000	58, 000	864	637	78	62	608	387	686	448
Arizona	32, 000	20, 000	1, 646	1, 024	148	99	1, 159	622	1, 307	721
Utah	21, 000	81, 000	1, 834	1, 245	165	121	1, 291	756	1, 456	876
Nevada	5, 000	3, 000	1, 339	1, 136	121	110	943	690	1, 063	800
Idaho	93, 000	172, 000	1, 694	1, 280	152	124	1, 193	777	1, 345	901
Washington	90, 000	210, 000	1, 498	1, 446	135	140	1, 055	878	1, 189	1, 018
Oregon	88, 000	269, 000	1, 392	1, 014	125	98	980	615	1, 105	714
California	909, 000	127, 000	1, 291	970	116	94	909	589	1, 025	683

In all the principal barley-growing States and parts of States barley is more profitable and produces more pounds to the acre than oats. Table 1 indicates that as a matter of farm economy the barley acreage in the northern tier of States should be expanded at the expense of oats. That it is not more widely grown now is due to two causes: (1) Its rough awns make it an unpleasant crop to handle, and its value as a stock feed has not been realized by the farmers east of Montana; and (2) the brewing trade until recently so dominated the eastern markets that buyers of feedstuffs did not think of barley as a feed crop. Barley must be considered as a feed in order to appreciate its true farm value. Not alone pounds, but pounds of digestible nutrients, should be considered.

TABLE 2.—*Digestible nutrients in each of the common cereals, as determined for animal feeds, according to Henry and Morrison*

Cereals determined	Digestible nutrients (per cent)				
	Crude protein	Carbohydrates	Fat	Carbohydrates and fat (×2.25)	Total
Barley	9.0	66.8	1.6	70.4	79.4
Oats	9.7	52.1	3.8	60.7	70.4
Corn	7.5	67.8	4.6	78.2	85.7
Wheat	9.2	67.5	1.5	70.9	80.1

In Table 2 the protein, fat, and carbohydrate contents of the four leading cereals are estimated from the analyses compiled by Henry and Morrison. In order to separate clearly the protein from the fat, the carbohydrates and fat (× 2.25) have been united into a nonproteid factor, which has been used in Tables 1 and 2. The total is the sum of the proteid and nonproteid constituents.

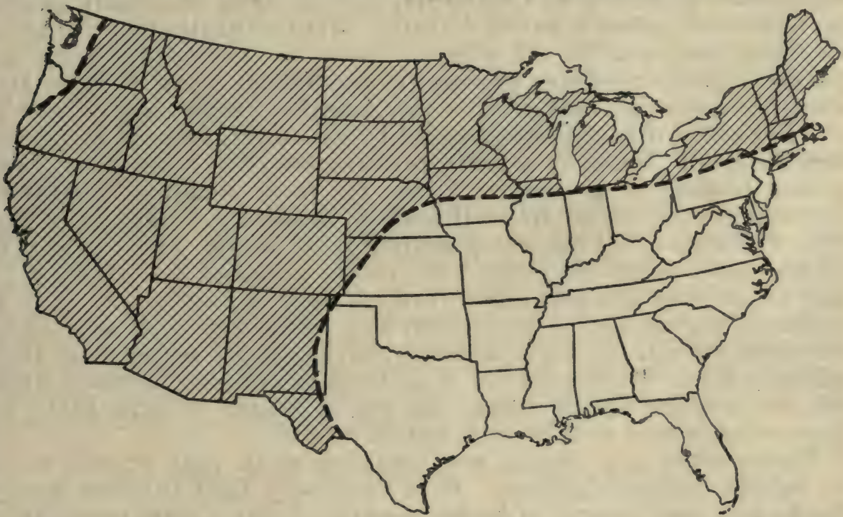


FIG. 2.—Outline map of the United States shaded to show the area in which the climate is relatively favorable for the production of barley. Within the shaded area well-drained soils that are not sandy in character produce more pounds to the acre of barley than of either oats or wheat, while corn is a competing crop only along the southern margin. The actual line of separation is irregular. Barley culture extends south of the line on favorable soils, as in northwestern Ohio, while oats are more profitable north of the line on soils unfavorable to barley production, as in north-central Iowa and southwestern Minnesota. In the mountain and Piedmont regions of the South there are local areas well adapted to winter barley

The area in which barley often can be profitably substituted for oats is shown graphically on the map (fig. 2). This does not mean that there are no localities in this area in which it is not more profitable to grow oats or that there are no localities outside this area in which it is profitable to grow barley. It does mean that within the area the general climatic and soil conditions are more favorable to large yields of barley than of oats. In Table 1 the average yield of barley, as may be seen, is higher than of oats not only in the Northern and Western States, but the same is true for many other States as well. In many of these, however, the total production is so small as to be unfair to the oat acreage. Where the barley of a State is largely localized in a definite section of the State, small acreages have more meaning. A long-established local area is usually based on sound economy, but even here modifications are constantly arising. In the winter-barley section of Tennessee and Kentucky, for example, winter-barley production has been much more profitable than that of oats. The Hessian fly may alter this relation, as barley must be sown before the fly-free date.

Although it has been estimated[1] that 161 acres of oats are equal to 167 acres of barley in California, this is true only because of the local demand for the oat hay or grain. As a matter of fact barley and oats hardly enter into competition in this State, profitable oat production being decidedly limited as to area and confined mostly to the edges of the barley-growing districts. In California, as a whole, barley is much more profitable than oats. Wheat is the real competitor of barley in California, as it is more commonly grown on lands well suited to barley culture. Hunt estimates that 235 acres of wheat are equal to 167 acres of barley in income-producing capacity. The progressive decrease in the annual wheat acreage and the progressive increase in the barley acreage sustain these estimates.

The profits of barley are modified by the cultural reason for growing the crop. Often it is not a primary crop but a secondary one, grown because of its special fitness for some abnormal condition. In certain districts, as in northwestern Kansas, it is largely second choice to wheat. If the wheat seeding is successful, wheat is grown. If for some reason the ground can not be prepared for wheat, or if the wheat does not germinate through lack of rainfall, or if it is winterkilled, spring barley is sown as a catch crop. On account of its rapid growth and early maturity, barley can be seeded later than other grains. This character is utilized in the spring-wheat area. On lands where spring wheat can not be seeded in time, barley is grown and is sure to give some sort of return.

Barley often is grown on new breaking, as its rank growth tends to subdue the wild grasses. It is commonly used to clean weedy fields, as a good growth of barley smothers many species completely. Its early maturity permits the crop to be cut before many other species have matured seed. Summer fallowing after the harvest destroys many more, and a single season of such treatment results in a marked decrease of the weed population.

Barley also is widely grown on old lands. After land has become too poor to produce good crops of wheat, it is seeded to barley. This sequence has been especially conspicuous in California. In Minnesota and Wisconsin the best barley is produced on old farm lands, which there happen to be of a fertile character. Older lands, where suitable in character and not too depleted, produce a better quality of barley than new lands.

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[1] T. F. Hunt and others. Some things the prospective settler should know. *In* Calif. Agr. Exp. Sta. Circ. 121, pp. 1–39, illus. 1914.

From the standpoint of profit, these various cultural uses of barley must be considered. The returns from a catch crop or a weedy field can not be compared with those of a primary crop, yet a very considerable percentage of the barley acreage is grown on this basis. The figures in Table 1 would doubtless be more favorable to barley production if there were some way to compensate for these legitimate but hardly comparable acreages.

In general the results of the experiments conducted by the Office of Cereal Investigations are in agreement with the census figures shown in Table 1. When comparisons are made of the best variety of barley with the best variety of oats at stations in the northern Plains area and States to the west, the returns from barley in most instances are decidedly greater than from oats.

FARMS AND SOILS WHERE BARLEY SHOULD BE GROWN

Obviously, barley should be grown on those farms where it is more profitable as a cash or feed crop than the other small grains, if the growing of a small grain fits into the scheme of field management. As has already been pointed out, this means large areas in the Northern and Western States and small areas elsewhere. Its profitableness or unprofitableness depends entirely on how nearly its optimum requirements of growth are met. Barley is a cool-weather plant. The months of growth in the heavy-producing regions will be found to satisfy this requirement, and the greater part of the crop should be grown in these established areas. Within these areas favorable soils should be chosen.

Barley should not be grown on poorly drained land. Porous soils are preferred. With drainage or light rainfall, heavy soils produce good crops. Sandy soils, even though well drained, are not good barley soils. Clay loams are perhaps the best for barley. Barley produces well on rich, new lands, and it can be grown more profitably than wheat on older lands, provided they are not too light and are well drained. Farms outside the average limit of profitable production, but still in a favorable climate, which possess desirable soil characters may be cropped to barley with profit.

PLACE OF BARLEY IN THE ROTATION

Over much of the barley-producing area no consideration is given to rotation of crops. Barley is still grown extensively rather than intensively in most of the Western States. Such rotation as is practiced is with the other small grains and ignores the greater objects of a rotation. Even in this area smaller farms are becoming common, and with the increase of livestock will come a diversification which will permit a cropping system now possible only in individual cases. East of the Red River Valley, barley is grown more as a crop of small farms which can enter into a cropping scheme. Wheat is the preferred cash crop over most of the barley region. Any rotation must consider wheat, but as this merely adds one year to the cycle the scheme is not materially altered. In sections where barley may lodge, a crop of wheat following a manured corn crop is of advantage to the barley.

In general, barley does best after a cultivated crop. This in the United States means corn. In Canada excellent returns have been obtained after root crops. In the United States the root-crop acreage is limited to potatoes and sugar beets. The total acreage of these available for seeding to barley is too small to be considered. In the humid districts, where diversified farming is practiced, the most feasible rotation is one including corn and a leguminous hay or pasture crop.

Corn followed by barley (seeded with grass), which in turn is followed by hay or pasture, is the essential combination of a rotation for this area. This, of course, is to be modified to suit local conditions and the nature of the farm. If intended for use as hay, the grass-seed mixture might be timothy and clover; if for pasture, the mixture might include a legume and nonleguminous grasses suited to the locality. If used for hay, the grass mixture would probably stand two years; if for pasture, it might remain a longer time. If grain feed is needed, two years of corn or two of barley might be used. In the case of two years of barley, the second year the barley might be sown at a lesser rate, so as to make a better nurse crop.

Where alfalfa is used it is seldom profitable to break up the alfalfa land in less than three years, and it is usually profitable to leave it still longer.

In the arid regions corn is a far less common crop. The acreage is increasing, however, and the use of silos is certain to extend it still farther. Investigations have shown[2] that on the Great Plains the largest returns per acre were obtained after summer fallow, but on account of the cost of summer tillage the crops on disked corn ground were much more profitable. Potatoes, where grown, occupy the same place as corn in the scheme of rotation. In eastern Oregon and Washington and to a lesser extent in Idaho, Wyoming, and Montana, field peas may take the place of both the corn and the hay crop, the rotation probably being peas, wheat, and barley. Much of the barley west of the ninety-eighth meridian is certain to be grown without definite rotation until economic conditions have altered considerably. In the South winter barley occupies the same place as wheat. The best returns are obtained after plowing under a leguminous crop, as after cowpeas plowed under the first of September. In the Piedmont region corn in which crimson clover is seeded, crimson clover followed by cowpeas, and barley make a 3-year rotation which can be extended by the use of a second barley crop and, if in a stock-raising region, by the addition of pasture. In the Coastal Plains barley does not succeed well on sandy soils, and stock farming is not common. Where the soils are suitable, corn, cowpeas, and barley may form the basis of the rotation. In some places velvetbeans are much better than cowpeas. The advisability of growing barley there usually would depend upon the relative cash returns of wheat and barley. In the South there is a possible exception. Where hogs are raised and fattened on peanuts, barley may be of unusual value in adding firmness to the fat.

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[2] Chilcott, E. C., J. S. Cole, and W. W. Burr. Barley in the Great Plains area: Relation of cultural methods to production. U. S. Dept. Agr. Bul. 222, 32 pp., illus. 1915.

MANURES AND FERTILIZERS

Most of the barley of the United States is grown outside the regions where the use of commercial fertilizers is common. Even barnyard manures are little used in the arid regions. It is likely that the extensive use of both commercial fertilizers and barnyard manures will be confined to the two humid regions for some time to come.

BARNYARD MANURE

Barnyard manure, when well rotted, is the best farm fertilizer. It not only supplies plant food but stimulates many desirable forms of bacteria found in the soil. It gives the soil a better texture and a higher moisture-holding capacity. In the humid-spring region it is best applied to the crop preceding barley, preferably corn. In this region the quality of barley often suffers from too much nitrogen, and the straw lodges easily. The addition of a nitrogenous manure causes a ranker growth, which usually results in lodging and difficult harvesting. In the South, where the soil is not so rich, manure plowed under in time to be well decomposed by seeding time is very beneficial.

COMMERCIAL FERTILIZERS

The use of commercial fertilizers for barley is limited to the eastern part of the United States. It is probable that profits could be obtained from their application in sections where it is not a common practice. It is improbable, however, that this is the most desirable way of investing such cash surplus as may be available west of the Mississippi River. The greatest need, of course, is in the South. Lime is the cheapest and most easily procured of the commercial fertilizers. It is not a simple fertilizer, like nitrogen, for instance, since it is applied to correct acidity and only incidentally to supply calcium. Many of the soils of the humid-winter regions are acid. The use of lime is common throughout the South. Lime can be more evenly distributed with a drill than by hand. In the Eastern and Southern States 1,500 pounds of burnt lime or 3,000 pounds of crushed limestone to the acre can be applied to advantage where lime is needed. The frequency of application depends both on the character of the soil and the nature of the crops grown. Some soils require an application only once in several years, and it is seldom that lime is required more frequently than once in three years. The application should be so timed in the rotation that clover and similar crops are grown upon recently limed soil, while rye and other acid-enduring crops are grown when the supply of lime is lowest.

Applications of lime are doubly important when barley is used as a nurse crop for red clover, which can not be grown on an acid soil.

The three elements usually supplied by the so-called complete fertilizers are nitrogen, phosphorus, and potassium. Nitrogen is commonly secured in nitrate of soda and ammonium sulphate or from such organic materials as tankage and cottonseed meal. Phosphorus is usually obtained in acid phosphate or the raw rock phosphate from which the acid phosphate is manufactured. Basic slag and bone meal, which contain phosphorus, are also widely used. The phosphorus in the acid phosphate is much more available than in the raw rock. The acid form is to be preferred. Raw rock is best used in heavy applications in connection with green manure or in mixing it with stable manures some time before applying it to the field, or sometimes by a daily addition to the stable accumulations. If raw rock is used in complete fertilizer, the nitrogen can best be added in ammonium sulphate. Potassium can be secured as kainit and sulphate or muriate of potash.

In grain farming complete fertilizers are also used. The formula varies so with the nature and condition of the soil that exact proportions can not be given. Even the basis of the quantity removed by the various crops is not particularly significant, because one or more of the three elements in question may be present in abundance.

In general, for grain farming in the Eastern and Southern States a fertilizer approaching a 3–10–3 formula will be satisfactory; that is, a complete fertilizer with nitrogen, phosphorus, and potassium present in the proportions given.

The aim of every farmer, however, should be to avoid the use of a complete fertilizer. Fertilizers are expensive, and a proper handling of the farm enterprises may cut down their use materially. No farmer should find it necessary to purchase nitrogen. Nitrogen can be secured free from the air by the use of clover, alfalfa, cowpeas, soybeans, velvetbeans, or vetch. Any scheme of crop management should embrace one or more of these crops. The rotation mentioned earlier provided for supplying nitrogen by this means.

Potash is usually present in sufficient quantity, though not always available. Green manures and barnyard manures tend to make potash available. The same scheme that adds the nitrogen will ordinarily free sufficient potash for the needs of the crop. Phosphorus alone is the element that may need to be supplied direct to farms of the East and South. The more livestock enters into the management of the farm the less phosphorus will need to be added. The scheme of adding phosphate to the stable manure is ideal, but seldom sufficient. Only the most specialized of livestock farms produce enough manure to cover their entire area in any reasonable number of years. Green manures and legumes must supplement these applications; and to them, in certain areas, phosphates must be added to maintain a high productivity.

GOOD SEED

Good seed is an insurance that the crop makes its initial growth without handicap. It means a good deal more than merely seed that will grow. It means seed that will grow vigorously and mature a desirable sort of grain that is free from disease.

To obtain such seed it must be, first, a desirable variety. The varieties are discussed later. The seed must be from a field that was properly cared for the previous year. The grain should have been well matured and so shocked and stacked that it escaped weather and heat damage. Grain that has passed through the sweat in the stack germinates more vigorously and in higher percentage than that threshed and placed in the bin immediately after cutting. Weather damage in the shock seriously injures the vitality of the seed.

The grain should be free from weed seeds and diseases. Noxious weeds are often introduced on the farm through the seed. It is much cheaper to pay a few cents a bushel more for certified seed than to use seed of doubtful character. It is better to get seed from clean fields than to treat it for diseases. Where diseases are present in quantity they should be treated or disease-free seed obtained.

Seed that is otherwise desirable often has a percentage of poorly developed kernels. These can be removed with a fanning mill. Good plants can sometimes be obtained from small seed, but they are likely to be weak and are usually crowded out. It is best to remove the lighter grain and use it as feed. The fanning mill while performing this function will at the same time remove many kinds of weed seeds.

PREPARATION OF THE SOIL

The ideal seed bed is one in which the bottom is firm but not too hard for the easy penetration of water and the growth of roots, while the upper 2 inches are loose. The soil should be so firm that few grains will fall in spaces too large to secure the contact with moist surfaces necessary for germination and thus result in an uneven start. The right kind of a seed bed is shown in Figure 3.

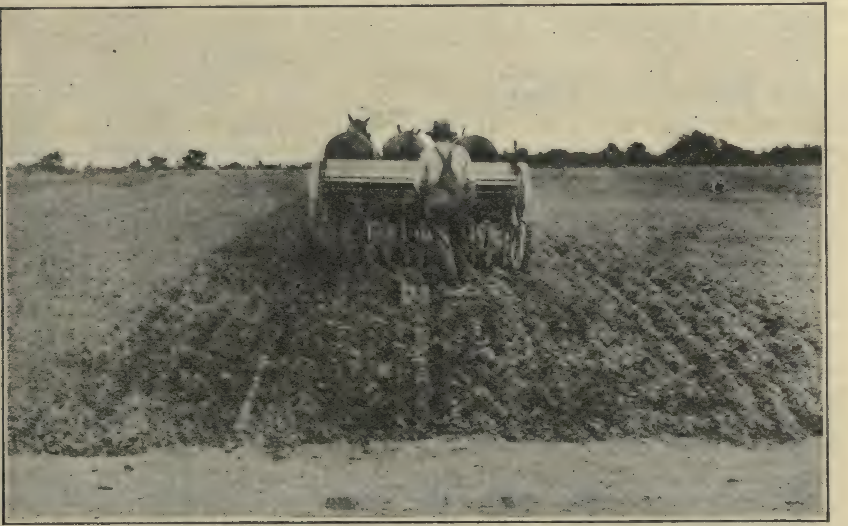

FIG. 3.—Drilling grain on a well-prepared seed bed

The aim of the operations in seed-bed preparation is to approximate the ideal seed bed at the least possible cost. Very comprehensive data on seed-bed preparation in the Great Plains area have been published by the United States Department of Agriculture.[3] The figures are not directly applicable to other barley-growing sections. The results are based on pre-war costs and prices and therefore are purely relative. The figures are so suggestive, however, that one of the tables is copied in this bulletin. (Table 3.)

Both production and profits are shown. These, of course, vary from day to day. The price used as the basis of cost computation in Table 3 is 41 cents per bushel in the shock, or 47 cents per bushel for threshed barley. At that price disked corn ground was found to be the most profitable on the Great Plains. In the humid-spring areas disked corn ground or fall plowing is probably the cheapest. From the point of returns, fall plowing is best in this region. In the Dakotas preference is frequently given to wheat, and the barley crop is placed on late spring plowing, which is harrowed and sown at once. Necessity justifies this practice, as it is often the only possible way to put in a crop. When this is done, all the labor which can be given without sacrifice of acreage should be devoted to the reduction of the soil to a firm condition.

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[3] See footnote 2, p. 8.

TABLE 3.—*Comparison of the average yields and profit or loss in the production of barley by different methods of tillage at 14 stations in the Great Plains area*

[Data according to Chilcott, Cole, and Burr. The profits and losses were based on pre-war prices for equipment and labor and a farm price of 47 cents per bushel for barley]

Stations	Number of years averaged	Methods of tillage						
		Fall plowed	Spring plowed	Listed	Sub-soiled	Disked	Green manured	Summer tilled
Yields per acre (bushels):								
Judith Basin, Mont	5	24.0	24.0	29.0	30.5	29.0	--------	30.2
Huntley, Mont	2	--------	29.6	--------	--------	34.5	43.8	--------
Williston, N. Dak	5	17.4	16.1	--------	--------	27.5	--------	28.8
Dickinson, N. Dak	6	25.1	24.6	--------	--------	37.4	--------	32.5
Edgeley, N. Dak	8	16.7	18.5	--------	--------	23.4	--------	20.0
Hettinger, N. Dak	3	19.9	25.5	--------	--------	14.9	--------	31.8
Belle Fourche, S. Dak	6	7.6	8.3	7.7	8.0	12.2	--------	12.6
Scottsbluff, Nebr	2	14.0	15.4	14.4	15.0	18.6	--------	27.6
North Platte, Nebr	8	17.1	15.9	--------	--------	13.4	--------	26.7
Akron, Colo	6	18.6	18.8	17.9	14.0	18.4	--------	24.8
Hays, Kans	6	13.6	11.2	12.7	14.6	14.1	15.5	19.3
Garden City, Kans	5	6.9	4.3	8.3	6.9	8.9	--------	11.0
Dalhart, Tex	4	3.9	1.9	4.4	--------	1.6	--------	6.4
Amarillo, Tex	6	8.2	5.7	6.1	6.8	6.6	--------	12.6
Profit or loss (−) per acre:								
Judith Basin, Mont	5	$3.38	$3.85	$6.44	$5.44	$7.24	--------	$0.98
Huntley, Mont	3	--------	6.15	--------	--------	9.50	$3.45	--------
Williston, N. Dak	5	.67	.61	--------	--------	6.63	--------	.41
Dickinson, N. Dak	6	3.83	4.10	--------	--------	10.68	--------	1.93
Edgeley, N. Dak	8	.39	1.60	--------	--------	4.94	--------	−3.20
Hettinger, N. Dak	3	1.70	4.47	--------	--------	1.46	--------	1.64
Belle Fourche, S. Dak	6	−3.34	−2.59	−2.29	−3.79	.35	--------	−6.23
Scottsbluff, Nebr	2	− .72	.32	.45	− .92	2.98	--------	− .08
North Platte, Nebr	8	.55	.53	--------	--------	.84	--------	− .55
Akron, Colo	6	1.17	1.72	1.89	−1.33	2.89	--------	−1.23
Hays, Kans	6	− .88	−1.40	− .24	−1.08	1.13	−8.15	−3.49
Garden City, Kans	5	−3.63	−4.23	−2.05	−4.24	−1.00	--------	−6.89
Dalhart, Tex	4	−4.86	−5.21	−3.65	--------	−3.99	--------	−8.78
Amarillo, Tex	6	−3.10	−3.65	−2.95	−4.28	−1.94	--------	−6.23

In California plowing is usually delayed until the fall rains begin. Much of the sowing is on land that is plowed in January or February and even in March. The seed bed is frequently far from ideal. After summer fallow the seed bed is good and needs no modification. In fall plowing, advantage should be taken of all the early rains and a seed bed prepared as early as possible. The disk can be used after the first rain and the ground made more receptive and the plowing easier. The custom of volunteer crops should be discontinued. Disked land should be used only when there is not time for plowing, as early seeding is an important consideration in California except on subirrigated lands.

In the South winter barley is seeded after a variety of crops. Although good results are sometimes obtained after corn, that crop is too late in maturing to prepare the soil for the best time of seeding. For this reason it is not advised. If seeded after corn, a disk is the best implement for preparing the seed bed.

When barley follows a small-grain crop the land is frequently plowed immediately after harvest and allowed to lie fallow until fall. Cowpeas can be grown to advantage after winter grain and turned under as green manure. In this case the ground should be plowed some time before seeding, to allow it to settle as much as possible. If the pea crop is removed for hay, disking is preferred to plowing.

DATE OF SEEDING

The maximum returns from barley are obtained when the crop is seeded early. The fact that spring barley can be seeded late and still mature a partial crop has led to considerable abuse of the latitude that its early maturity makes possible. It is the common practice to seed barley after the seeding of oats and spring wheat has been completed. From the farm standpoint this practice is justified by the requirement that the oats and wheat must be sown early. From the standpoint of barley culture, it is not good practice and results in reduced yields. As a matter of fact, spring barley should be sown at about the date generally observed for sowing spring wheat if the best results are to be obtained. In certain localities where the spring opens late this is not always possible, but the losses arising from late seeding should be realized and all efforts made to hasten the spring work. Large grain farms, such as are found in North Dakota, present the most difficult problems. The work on all crops falls in a very short period, and if weather conditions are adverse it is not physically possible to complete the seeding during the period when the best results are to be obtained. It has been shown[4] that the period of barley seeding in North Dakota extends over 25 days, whereas in Wisconsin the seeding is accomplished in 16 days. This means that in Wisconsin barley is a primary crop, grown on farms so small and so diversified that the farmer grows it for the sake of the barley crop and is able to seed it near the proper time for seeding barley. In North Dakota, on the contrary, barley is seeded when the wheat and oat seedings permit. In Wisconsin the greater part of the crop is seeded during the most favorable period. In North Dakota most of it is seeded later than this period.

Of course, there is variation from season to season, but, in general, barley should be seeded as early as the ground can be worked well in the spring. If the soil is of a heavy, cold character it should be seeded a little later than the lighter soils, as the soil must have some warmth at seeding time. The recommendation of early seeding should not be followed to such an extreme as to plant the grain in a backward spring in soil that must be worked wet to prepare it for such an early date. Neither should the ground be allowed to remain weedy in order to hasten the date. On the other hand, no time should be lost when the ground can be worked with safety, especially if it has acquired some warmth. On the northern Plains, the most favorable period is from April 1 to April 25. Figure 4 indicates the yields according to time of seeding in Montana, North Dakota, and South Dakota, from data made up from the experiments at a number of stations. In only one instance at one station did the earliest date produce less than the maximum yield. After April 20 the yields began to be somewhat less, and in no case did seeding as late as the first of May produce a maximum yield. The loss after April 25 is more than 1 per cent a day. These tests were all in well-prepared seed beds, and it is possible that the earliest seedings on soil that is less well prepared might not produce results as favorable as those here shown. It is certain that the falling off in yield would show as quickly on any seed bed, owing to less favorable climatic conditions during the ripening period.

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[4] Covert, J. R. Seedtime and harvest: Cereals, flax, cotton, and tobacco. Dates of planting and harvesting east of meridians 102–104 in the United States. U. S. Dept. Agr., Bur. Statis. Bul. 85, 152 pp., illus. 1912.

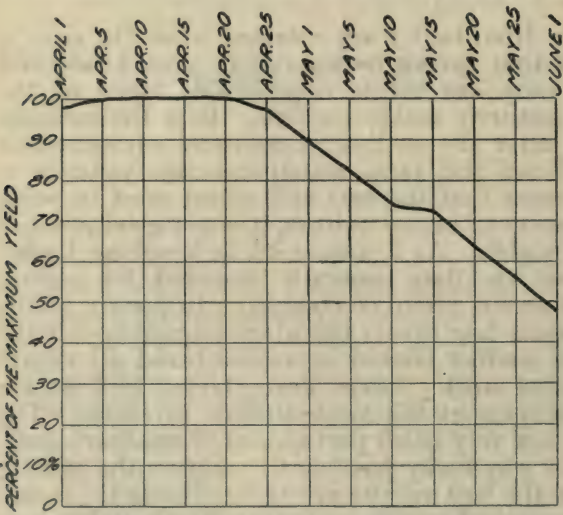

FIG. 4.—Diagram showing the percentage of the maximum yield that has been obtained on various dates of seeding at field stations in North Dakota, South Dakota, and Montana. Seeding later than April 25 has resulted in a loss of more than 1 per cent for each day that seeding was delayed. Seeding the last of May has given only about 50 per cent of the maximum yield. In southeastern Minnesota and Wisconsin the best date to seed is correspondingly earlier

The loss of at least 1 per cent a day after April 25 must be reckoned as a probable average for a series of years. This means that on a field of 50 acres of barley which if seeded in time would yield 30 bushels per acre there is a loss for the field of at least 15 bushels a day for every day that seeding is delayed beyond April 25. This is the average date for these States. In Montana and the extreme northwestern portion of North Dakota the date is three or four days later, and in some parts of South Dakota it is three or four days earlier. The variation is not as much as would be expected. The seasons in southern Minnesota, Iowa, and Wisconsin are slightly earlier, and the consequences of late seeding are more disastrous than in the case of the other States mentioned. Seeding as late as the first of May in southern Minnesota and Wisconsin is to be discouraged. In New York and New England the cool summer permits a slightly later seeding. In Oregon and Washington spring-sown barley should be put in as early as possible. In California data collected by G. W. Hendry show that early seeding (before December 20) produces the maximum yields, whereas late seeding (after January 25) shows a yield more than 20 per cent less than the earlier date.

In the Southeastern States winter barley must be seeded early. September seeding has given good results at most places in the barley-producing area. In the southern edge of the humid-winter belt October seeding is frequent.

RATE OF SEEDING

The best rate of seeding barley varies widely with the season, and maximum yields are obtained at rates covering a wide range. A single plant accommodates itself to its individual conditions. If it is crowded by other plants it produces only one or two culms, but in an open space it may produce several. The best rates are usually heavy enough to insure that the thinnest spots on the field will have enough plants for a maximum yield. In the humid regions this maximum under favorable conditions might be obtained with a seeding of 5 pecks per acre, yet at the same time 10 pecks per acre would not decrease the yield. As the seed bed is not usually perfect and as adverse weather conditions subsequent to seeding may decrease the stand, 2 bushels per acre are usually seeded in the humid sections. On the northern Plains 4 pecks per acre have given about the same returns as 8 pecks. Four to 6 pecks are usually recommended. Six pecks are too much in the driest years and in localities where the average season is known to be severe. Four pecks are recommended

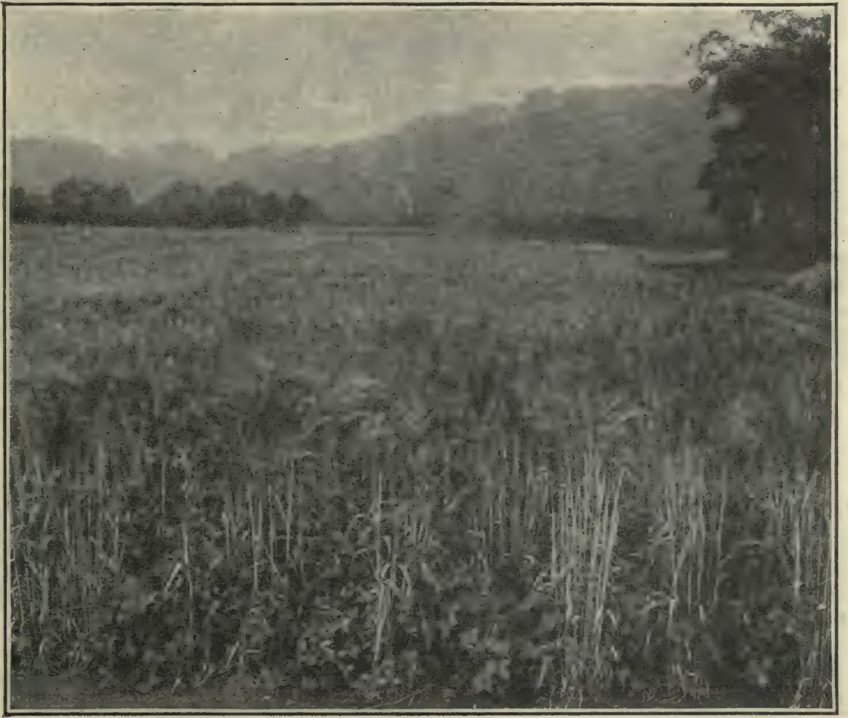

FIG. 5.—A field showing winter barley as a nurse crop for red clover

for such places. In other parts of the northern Plains, especially along the eastern limit, 6 pecks may often be sown to advantage, though it is usually more than is necessary if the seed bed is in prime condition. In the very driest localities of the Dakotas and Montana and in the Great Basin, 3 pecks are sometimes seeded to advantage. In California 7 pecks per acre are usually seeded. In the winter-barley districts of the Southeastern States 8 pecks are recommended. Where a naked variety is grown, not more than three-fourths of the rate for hulled barley should be sown. Where barley is grown as a nurse crop, about 25 per cent less grain should be seeded than for a grain crop, as a thin stand allows a better growth of forage plants, a good stand of which is shown in Figure 5. When grown for pasture, the rate should be increased 25 to 50 per cent.

DEPTH OF SEEDING

The seed of barley should be placed in the ground at such a depth that it can get both moisture and air. In the humid regions, if planted too deeply, excessive moisture may shut off the air supply and reduce the temperature to the extent of decreasing the germination. In the arid region too shallow planting may result in poor germination through lack of moisture. In the humid regions the best conditions are found at a depth of about 1½ inches. On the northern Plains this should be increased to 2 inches. In the Great Basin the best depth is from 2½ to 3 inches. At Nephi, Utah, 3 inches was found to give the best results for the depths tried, but no seeding was made at 2½ inches.

METHOD OF SEEDING

Drilling with a grain drill is the best method of seeding barley. The drill is constructed for the purpose of placing every seed in the most favorable location. For this reason it is much more economical of seed than broadcasting. Under favorable conditions of soil and moisture, broadcasting may produce yields as high as those obtained from drilled seed. As the conditions become adverse, the results are more and more in favor of drilling. In the drier regions the grain must be placed at some depth beneath the surface to secure an even germination. This can not be done uniformly by any means except the drill. Any good grain drill will do the work successfully on a well-prepared seed bed. If the ground is covered with trash, as disked corn ground, the single disk drill is to be preferred.

Broadcasting should not be practiced where it can be avoided. It is particularly undesirable to broadcast seed on dry ground, as part of it may be harrowed in deep enough to germinate, while the rest may lie for days awaiting a rain to start growth. This results in a very uneven stand. In moist soil, under favorable conditions, broadcasting is not so objectionable. In the interior valleys of California where the plowing, seeding, and harrowing must be done quickly, before the rains begin, broadcasting is often employed to save time. Even there, although conditions are unusually favorable to broadcasting, better results are obtained with a drill, and where the ground is in suitable condition and sufficient equipment is available to seed the acreage without delay a drill should be used.

TIME OF HARVESTING

The time of harvesting barley depends on the use of the crop, the variety, the climate, and the method used.

For seed, brewing, or feed, the crop should be mature. The maturity should not be judged by the earliest spikes. If possible the latest spikes should be mature, as this will insure that no part of the crop will be shrunken from having been harvested too soon. If the stand is thin or uneven this may not be possible, as the earlier spikes of many varieties would begin to shatter. By maturity is meant the point where material ceases to be added to the kernel and not that the grain has become bin dry. There are several popular tests which indicate this period. The kernel at this time can be dented with the thumb-nail and retains the dent for some time. The milky juice largely disappears from the furrow. The hull begins to wrinkle on the ripest grain, showing the shrinkage of the kernel beneath. After this point is reached, ripening is merely the loss of moisture and can take place in the shock as well as if the crop is left uncut.

Nurse crops of barley are often cut somewhat earlier than grain crops, but this is for the purpose of favoring the development of the grass seeded with the barley and does not enter largely into the general problem of barley harvest.

As a hay crop barley is harvested still earlier. It is not cut while in bloom, however, as is customary with many of the grasses. The grain is allowed to develop almost to its maximum. The grain content of barley hay constitutes a considerable part of its feed value. Barley is highly prized as a hay crop in the West, despite the coarse awns which frequently cause sore mouths in horses and cattle. Sometimes the hooded varieties are grown for hay in order to eliminate this objectionable factor. Much of the hay, however, is incidental; that is, the barley is sown for grain. If the season is favorable, it is harvested for grain; if unfavorable, it is harvested for hay.

The time to harvest sometimes depends on the variety. Some varieties shatter badly when ripe, while others do not. Hooded and awnless sorts shatter most easily. The Coast type (Bay Brewing, California Feed, etc.) shatters much less than the other types. The types which shatter must be harvested promptly. The best of the Coast type can be left until the full maturity of the latest culms and suffers but moderate losses for some time after complete dryness.

The climatic conditions at the time of harvesting have some influence on the stage at which barley is cut. In a section subject to storms the harvest must be accomplished within a very few days. If the straw is too green it will not dry properly in a humid climate, and there may be mold damage. If harvest is delayed too long, much grain might be lost through the occurrence of a storm, as all barleys in humid climates shatter rather easily. In the arid region green barley dries readily, and storms are not so common as to cause shattering in the overmature crop. The varieties in the arid regions outside the Great Plains do not shatter readily.

METHODS OF HARVESTING

There are but three common methods of harvesting barley—by the use of the binder, the header, or the combined harvester. The grain binder is the implement of the intensive farmer and is by all means the best, where it can be used. The grain can be cut with less loss. It can be cut at the optimum time and in the humid regions can be stored with less damage than by the other methods. When cut with the header or the combined harvester, the grain is allowed to ripen more completely than when cut with the grain binder.

The header is important in the Plains region, where it is a rapid means of harvesting large acreages. It is very useful in harvesting crops where the straw is too short for the best use of the binder. Some varieties, such as the White Smyrna, are very difficult to harvest with a binder, on account of their short straw. The common use of the combined harvester is confined to the Great Basin and California.

When the combined harvester is used the grain must be ripened to dryness. In California the crop often stands three weeks after maturity before being cut. Only varieties of the Coast and Mariout types are suitable for this practice. None of the other common varieties will stand after they are ripe without losing a large part, probably the greater part, of the grain. In California, in a total yield of 31.1 sacks per acre there was a loss of 6.6 sacks per acre when the combined harvester was used, whereas only 1 sack per acre was lost when the grain binder was used.[5] This loss of 1 sack included the loss at the thresher. The loss of the crop by the use of the combined harvester was 21 per cent, while that of the binder was 3 per cent. Professor Hendry states that although it might be held that the shattering loss was unusually high in this case because the yield was above the average, observations made in various parts of the State would indicate that the contrary is true and that the percentage of shattering is usually higher in the case of the lower yields. He also states that while the cost of production is lower with a combined harvester, the net proceeds are in favor of the use of the grain binder.

The grain lost by shattering is sometimes allowed to volunteer for the next crop. This practice is not to be recommended, as it is unprofitable.

SHOCKING, STACKING, AND THRESHING

Grain is usually shocked after being cut by the binder. The object of shocking is to protect the grain as far as possible until it is threshed. The treatment of course varies with the climate of the section. The more humid the section, the more trouble is experienced in safely harvesting the crop. Weather is the main source of shock damage. The shocks should be built with this in mind. If the straw is not quite dry, oblong shocks without caps are best. If the section is one where windy weather prevails, the grain may be left in this form of shock until stacked or threshed. In the rainy districts, winds permitting, these oblong shocks should be changed to the round type and capped when dry. Ordinarily, of course, the grain is dry enough to put in a round shock and capped at once. After heavy rains, if the shocks have become wet inside they must be opened and the bundles spread out to dry. The bundles should be laid across one another in such a way as to keep the heads off the ground.

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[5] Hendry, G. W. Harvesting grain in California. The combined harvester v. the grain binder. *In* Univ. Calif. Jour. Agr., v. 3, pp. 129–137, illus. 1915.

The grain should stay in the shock as short a time as possible. Rain is certain to discolor and injure the cap sheaves. If the bundles become wet enough to require spreading, most of the grain will be discolored, at least. There are various species of fungi that aid in the discoloration, and if the grain remains moist any length of time odors of mold will persist after threshing. Discoloration and mold odors greatly lessen the price when the grain goes on the market as malting barley. Weather damage, aside from the direct loss of germinated grains, affects the viability of the seed and its value for seed and malting purposes. For these reasons the grain should be either stacked or threshed as soon as possible after it is cut. Stacking gives the finest quality of grain for seed or malting. The grain goes through the sweat in the stack, which seems to increase the percentage and vigor of germination. Sweating also occurs in bin grain threshed from the shock soon after cutting. Bin sweating is not as normal as that in the stack, and there is some danger of heating. There is some loss of weight in sweating, and properly cured barley should bring a higher price than grain direct from the field. It costs about 1 cent per bushel more to stack grain than to thresh from the shock. When grain is stacked the work should be carefully done and the stacks made in such a way that they shed water perfectly. Poor stacking may result in large losses. Unless skilled labor is available, it is better to stack under sheds or other shelters if it is possible to do so.

Barley must be threshed carefully. About one-eighth of the crop is used for malting. Its value for this purpose can be greatly affected by improper threshing. In the process of malting, barley is germinated at temperatures and in a humidity favorable for fungous growth. The grains are protected by a heavy layer of cells that surround the starchy interior. If this layer is injured the fungi gain entrance and feed upon the material stored in the grain. Injury in threshing comes about in two ways: (1) Many kernels are actually broken in half, and (2) many others are threshed too close. Close threshing breaks off the tips and exposes the body of the grain to attacks of fungi. The concaves should be so set as to avoid these injuries.

COST OF PRODUCING BARLEY

The cost of producing barley varies with the section of the country, the cost of man and horse labor, the price of seed, and the amount of capitalization. These items themselves vary from year to year in any section. At present the cost is considerably higher than it was before the war.

In Table 4 is given a compilation of the data published by several investigators.[6] Their work represents three general areas which present marked differences of economic conditions and cultural practices. The farms of the humid-spring region, where land values are high and the agriculture more or less diversified, are represented in the Minnesota averages. On the Great Plains, land values are low, with grain farming the main enterprise. In California, land values are about the same as in Minnesota. The barley is raised on farms devoted almost exclusively to grains and is usually harvested with the combined harvester. All figures are of the pre-war period.

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[6] See footnote 2, p. 8.
Peck, F. W. The cost of producing Minnesota farm products, 1908–1912. Field crops. Minn. Agr. Exp. Sta. Bul. 145, 48 pp., illus. 1914.
Hendry, G. W. Op. cit.

TABLE 4.—*Pre-war cost of producing an acre of barley in three representative sections of the United States*

Locality and method of preparation	Method of harvesting	Preparation of land	Seed	Seeding	Cutting and shocking	Interest, taxes, depreciation, and general expenses[1]	Total cost of grain in shock	Stacking and threshing	Total cost, threshed grain
Minnesota:[2]									
Fall plowed	Binder	$2.08	$1.58	$0.31	$0.81	$5.37	$10.15	$1.93	$12.08
Great Plains area:[3]									
Disked cornland.		.97	.75	.40	.93	1.60	4.65	--------	--------
Listed		1.77	.75	.40	.93	1.60	5.45	--------	--------
Spring plowed		2.31	.75	.40	.93	1.60	5.99	--------	--------
Fall plowed		2.78	.75	.40	.93	1.60	6.46	--------	--------
Subsoiled		3.39	.75	.40	.93	1.60	7.07	--------	--------
Summer tilled		6.12	.75	.40	.93	3.20	11.40	--------	--------
California:[4]									
Fallow	Binder	1.75	1.00	.40	1.55	11.17	15.87	4.30	20.17
Do	Combined harvester	1.75	1.00	.40	--------	11.17	--------	[5]3.40	17.72

[1] The sums given in the column of interest, etc., in the case of the Great Plains area include only interest and taxes and not depreciation and general expenses.

[2] Average of farms in three localities during the years 1908 to 1912, inclusive, according to Peck.

[3] Average of eight stations in the Great Plains area during the years 1909 to 1914, inclusive, as given by Chilcott, Cole, and Burr.

[4] Cost based on a 31-sack crop in 1915, according to Hendry.

[5] Harvesting (cutting and threshing).

In Table 4 some liberties have been taken with the figures of the various investigators. Hendry's figures, for example, were originally a comparison of the two methods of harvesting. He carries the cost to the place where the barley is in the warehouse. In the cost of threshed grain he includes sacks. These are omitted here because the figures would not then be comparable with those of the other investigators. As far as California is concerned, they should be included. Hendry's total cost in the warehouse was $22.79 for the combined harvester and $26.13 for the grain binder. Much of the extra cost of the binder comes from the extra quantity of grain handled, 5½ sacks more being obtained by the use of the binder than by the use of the combined harvester. The net profit per acre is greater with the grain binder.

In the cost per acre of grain in the shock the variations are of interest. The grain in the shock is the fairest point of comparison, as Chilcott, Cole, and Burr do not carry their figures farther. The overhead charges of Peck are just about half those of Hendry. In Minnesota a crop is raised every year, whereas in California a crop of 31 sacks could not be expected except when the land was fallowed every alternate year. The overhead charge of Chilcott, Cole, and Burr on the Great Plains is low, owing to low land values and to the inclusion of part of the depreciation in the labor cost. The overhead charge is the largest single item and the one commonly ignored by farmers who own their own land and equipment. Farmers usually figure their profit without considering either the interest on their investment or their own labor. In most of the barley-growing districts a satisfactory margin exists between the cost of production and the cash returns. From the current price of barley the number of bushels necessary to meet the cost of production is readily computed. It is the grain in excess of this quantity that constitutes the profit of the farmer. As the cost of farm labor and materials advanced greatly during the war the farmer must add this extra cost in making estimates at present.

USES OF BARLEY IN MANUFACTORIES

The market price of barley depends in part on its suitability for the use to which it is to be put. The present factory demands are: A reduced demand from domestic maltsters, an export demand for malting barley, and the normal market for pearling, breakfast-food preparation, and flour. The maltsters require a clean, well-matured, undamaged grain of high viability. Damage may result from either harvest, shock, bin, or threshing injury. Barley that is cut too soon—that is, before the grain is really mature—is usually classified as harvest-damaged grain. Shock damage arises from adverse weather conditions. This has been previously considered. Bin damage comes from the storage of moist barley or from leaks after storing. On the farm about the only remedy for bin heating is shoveling the grain to another bin when it heats. If floor space is available, spreading it out over a large area and shoveling it over every day or two will save very moist grain from injury. In elevators it is comparatively easy to aerate grain by running it into another bin. Musty barley makes musty malt and musty malt carries objectionable flavors into the malt liquors when used for that purpose. Threshing injuries promote the growth of molds in the germinating chambers.

Barley that is raised for malting should be of the variety or at least the type common to the region, unless previous arrangements have been made with the buyer and there are facilities for keeping it separate. A mixture of types is a sure cause for a decreased yield to the maltster. Different types germinate differently and can not be malted uniformly when mixed.

Pearled barley is made by the removal of the outer portions, leaving a round pellet which is free from hulls and bran. Barley for this purpose must be free from weather damage and unbroken, as it is impossible to pearl a broken kernel. The larger and more nearly spherical the kernel, the more economical is the process and the better the product. For these reasons large-grained 2-rowed varieties are grown for pearling. The best variety is the Chevalier. This variety can be grown well in Montana and the Great Basin under irrigation and sufficiently well in the delta lands of California. Where the Chevalier does not grow well, the Hanna may be substituted.

Most barley breakfast foods are made from malt. Their requirements, therefore, are those of malting barley. If naked barley were grown in large enough acreages in definite localities, it is possible that a better market for it might be secured for special purposes, Barley flour is new to this country, but the experience of 1917 has shown that in cases of wheat shortage it is a valuable reserve flour grain. Barley is usually seeded later than wheat and interferes little with the wheat acreage. It is a protection to our wheat supply, in case it is needed as a substitute for wheat flour. It can be milled by wheat mills and produces more pounds of flour per acre than wheat.

Barley flour when used alone does not make good raised bread. It can be mixed up to 20 per cent with wheat flour without detriment to the quality of the bread. For hot breads where baking powders are employed 80 per cent of barley flour may be used.

The future of barley flour in America depends to a considerable degree upon other factors than its nutritive and baking value. Unquestionably barley flour is nutritious, and it mixes very well with wheat flour in the making of bread. The addition of barley flour darkens the loaf, and this is the main obstacle to its regular use. The American housewife prefers a white bread, even at the expense of some food value. Although barley will not make as white a loaf as wheat, the desire for light color can be partially met by careful milling and the use of selected varieties.

Undoubtedly the first barley milled in this country was of too high extraction to be permanently satisfactory. The flour was nutritious and probably contained a large proportion of desirable mineral elements, but the dark color caused dissatisfaction. As high as 70 per cent of flour was often obtained, when the percentage from the trade standpoint should have been not more than 60 per cent and probably should have been less. Machinery or methods that completely eliminate the glumes and other enveloping tissues before or after grinding will doubtless add much to the appearance of the flour. In using the so-called blue varieties it may be necessary to remove the aleurone layer as well.

Some varieties are better suited than others for milling. Less waste occurs with large-grained varieties than with small-grained ones. If grown for milling, the sorts with white aleurone layers are preferable to those with blue aleurone layers. The Chevalier is perhaps the best variety for milling that is grown extensively at present. The White Smyrna and Hannchen are suitable varieties, adapted to certain sections mentioned elsewhere. Until there is a definite market preference which carries with it a noticeably higher price per bushel, the farmer can not be expected to sacrifice high-yielding varieties for those less well adapted. Where large-grained varieties with white aleurone layers produce as much as those with smaller grains or blue aleurone layers, the farmer may readily anticipate the demand by seeding them in preference.

STOCK FEED

The value of barley as a feed is not appreciated by the eastern farmer. In the West where corn is not grown, barley is utilized and is fed understandingly. In the humid region its possibilities have been so obscured by the habit of corn feeding that barley is hardly considered in livestock farming. On account of the high acre yield of corn, barley can not compete with corn where labor is sufficient to make corn the exclusive grain crop. Where small grain is grown as a part of the farming program, barley is often the most profitable.

The sections where this is likely to be the case are indicated on the map (fig. 2). Where grain is to be purchased to supplement the farm production, barley by all means should be considered. Pound for pound, its relative value is shown in Table 2. Its value as a feed is not entirely revealed in the table, since the suitability of different grains to different classes of livestock does not depend entirely on their chemical composition. Oats, for instance, are unsuited to the feeding of pigs because of the large amount of hull. Barley, on the contrary, can be used with success and is especially prized for the production of bacon. Barley, on account of its high protein content, is usually better for growing stock than corn, whereas corn is usually superior for a fattening ration. The following statement[7] indicates the value of barley as a feed:

> On the Pacific slope, where corn or oats do not flourish in equal degree, barley is extensively used as a feed for animals. The horses of California are quite generally fed on rolled barley, with wheat, oat, or barley hay for roughage. Barley is the common feed for dairy cows in northern Europe. The Danes sow barley and oats together in the proportion of one part of barley to two of oats, the ground mixed grain from this crop being regarded as the best available feed for dairy cows and other stock. Fed with legume hay to fattening steers and lambs, barley has given nearly as good returns as corn. For horses, barley is somewhat less valuable than oats. At the Virginia station,[8] calves made excellent gains on barley and skim milk, but corn proved cheaper. In Great Britain and northern Europe barley takes the place of corn for pig feeding, leading all grains in producing pork of fine quality, both as to hardness and flavor. In American trials somewhat more barley than corn has been required for 100 pounds gain with fattening pigs. * * * Though barley is somewhat higher than corn in crude protein, it is still decidedly carbonaceous in character and should be fed with legume hay or with a nitrogenous concentrate for the best results.

The food value per acre for barley has been indicated in Table 1, in which the pounds per acre have been multiplied by the percentages of protein and carbohydrates to show the pounds of digestible nutrients. Corn, on account of the high yield, gives higher returns than barley in the sections where corn can be grown.

FEEDING BARLEY

Success with barley depends in part on how it is fed. Barley fed whole is too hard for the best results, as much of it remains undigested. If barley is finely ground it makes a pasty mass in the mouths of the animals, which is evidently disagreeable, since they consume much less grain and consequently put on less flesh. The grinding machinery should be so set that the grain is merely cracked and not ground to the fineness of meal or flour. Where it can be done, a desirable method of preparation is rolling. Rolled barley is used throughout the West and should become common in the upper Missouri and Mississippi River valleys. In the latter regions the feeding of barley is much less common than it should be. Throughout this area barley is easily grown and can readily furnish the grain feed in a better balanced system of farming. It is desirable that a greater number of livestock be kept on the farms. Grain farming at usual prices is yielding gradually decreasing returns on some of the best farming lands, and it has been extended into regions where it is not and probably can not be made continuously profitable. The hope of improvement in each case lies in livestock. For adequate livestock husbandry a carbonaceous grain is necessary. Much of the area is beyond the limit of corn for grain, though it is profitable for silage. Barley has a real place in establishing this area on a firm economic footing.

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[7] Henry, W. A., and F. B. Morrison. Feeds and feeding. A handbook for the student and stockman. Ed. 15, p. 162. 1915.

[8] Fain, J. R., and M. P. Jarnagin. Grains to supplement skim milk for calves. Va. Agr. Exp. Sta. Bul. 172, pp. 83–94. 1907.

Barley is a good grain feed; cracked barley is better, and it is believed that rolled barley is still more desirable. The rolled product is shown in Figure 6. Any pair of heavy rolls will do the work. In the West there are large central mills which roll barley for a moderate charge. In these large mills the grain is steamed by a jet of live steam entering the stream of barley just before it reaches the rolls. The steam does not have time to penetrate the grain, which is in no way cooked or wet but merely moistened. The moisture thus added prevents any disintegration of the kernel and causes it to be merely flattened.

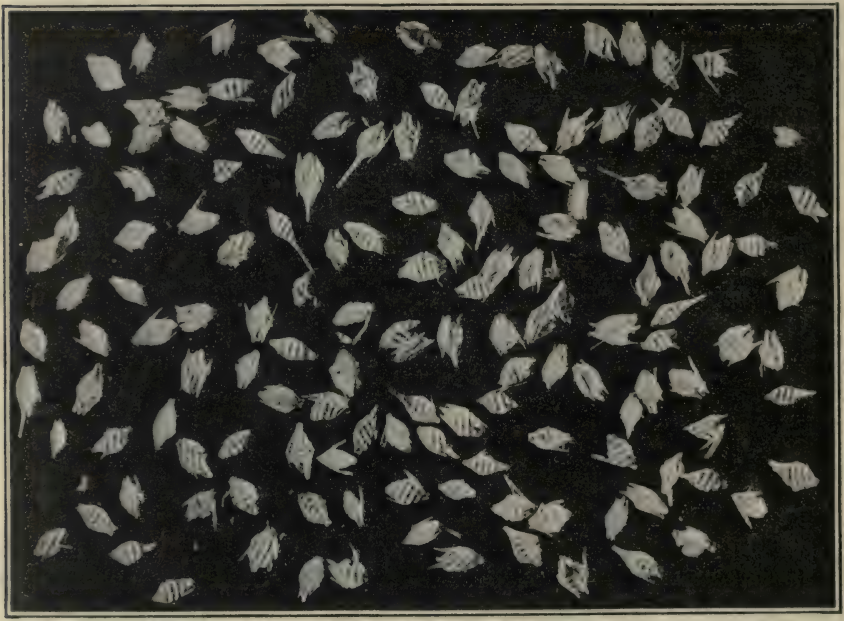

FIG. 6.—Rolled barley: A common way of preparing barley for feed in the West

There are small outfits on the market for rolling barley on the farm. In these there is no provision for steaming, and the product is in consequence not so desirable. Such outfits, however, may prove especially useful in the humid sections of the United States, where steaming might lead to storage difficulties.

PASTURING BARLEY

Winter barley is sometimes used for pasture in the South, but is of minor importance compared with winter oats or rye. When intended for this purpose, it should be seeded earlier than for a grain crop, so that the plants may become well established before the first cold weather. A heavier seeding than for a grain crop is desirable. Drilling is preferred to broadcasting. Barley is also used occasionally as a cover crop in this region.

VARIETAL REGIONS

The varieties of barley grown are grouped readily on the basis of the regions of production indicated on the map (fig. 1). Although some of the varieties that do well in the humid-spring area can be grown successfully in the semiarid regions, those typical of the semiarid region do not do well under humid conditions. Barley from neither of these regions does well in the humid-winter region. Each of these three regions is characterized by a predominating commercial type that is more or less well adapted to the whole area and that is almost certain to yield well wherever planted. In present practice the outstanding variety of the semiarid region is the Coast barley (sometimes known as California Feed or Bay Brewing), but it is not the most promising sort on the northern Plains. The characteristic type of the spring-humid region is the Manchuria-Oderbrucker. The Manchuria and Oderbrucker varieties, although of different origin, are very similar, and as neither is pure they are usually indistinguishable in the field. The best-yielding type in the humid-winter area is the Tennessee Winter. None of these types is a pure variety, and in each case high yields are obtained from their close geographical relatives when these are similar in type and source. These three types are shown in Figure 7.

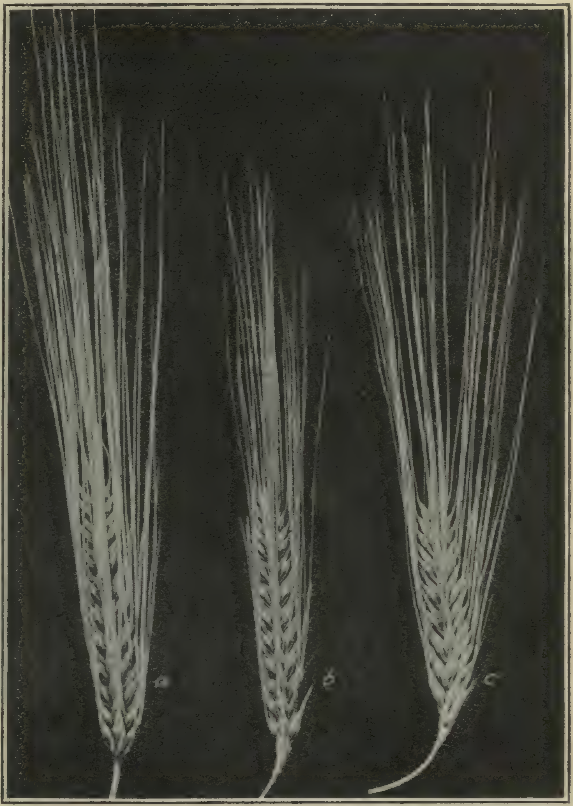

FIG. 7.—Spikes from the predominating variety of barley in each of the three climatic regions: *a*, Coast (semiarid); *b*, Manchuria (humid spring); *c*, Tennessee Winter (humid winter)

The Coast variety is a 6-rowed barley composed of many similar strains. In the typical strain the glumes are white, while the aleurone layer shows a blue tinge. All are large grained, of relatively low nitrogen content, and possess harsh awns which do not break off readily in threshing. Owing to the fragments of awns which cling to many kernels, the grain does not run through the drill readily; and the drill therefore should be set at a somewhat heavier seeding rate than if Manchuria, for example, were to be used. The Coast barley probably came from North Africa, most likely through Spain. Wherever the Coast variety does well, other North African barleys do well. South American sorts, which doubtless were introduced into South America from Spain, yield well in the semiarid region. One such has been grown to a small extent under the name Peruvian.

As previously remarked, the Manchuria and Oderbrucker barleys of the humid-spring region are very similar. Both are nodding 6-rowed forms having smaller kernels and more slender spikes and beards than those of the Coast barley. As in the Coast, they represent a type and not a pure variety. In each may be found white and blue-tinted strains. In field culture there is more blue in the Manchuria barley than in the Oderbrucker, and many of the selected strains of Oderbrucker are taller than the Manchuria. They have become so mixed that the original character of either is not easily determined. Selections of the Manchuria barley predominate in Minnesota and the Dakotas, whereas Oderbrucker selections are more commonly grown in Wisconsin. Although the Oderbrucker came from Germany, it probably has a common ancestry with the Manchuria. The only close relatives of the Oderbrucker and Manchuria barleys in farm culture are the Manshury and Scotch. The term "Manshury" is only a corruption of Manchuria, and the variety is

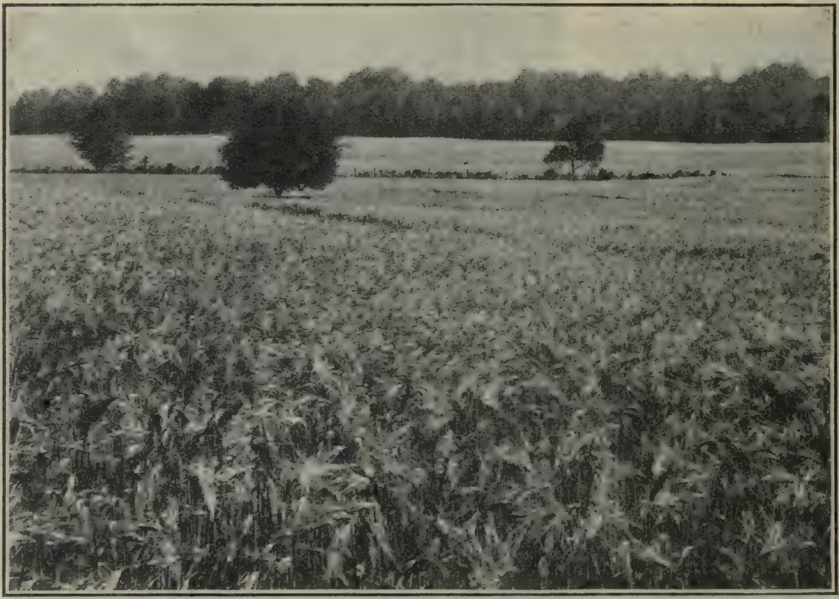

FIG. 8.—A field of Tennessee Winter barley

not a separate sort. The Scotch was formerly common in the districts now growing Oderbrucker, to which it is very similar.

The Tennessee Winter barley is similar in appearance to the Manchuria. It has three or four more or less indistinguishable companion varieties. The Maryland Winter and Texas Winter are probably identical with it. Professor Mooers, of Tennessee, states that the Union Winter differs constantly from the Tennessee Winter in time of heading and ripening. A field of the Tennessee Winter variety is shown in Figure 8.

VARIETAL AREAS

In each of the three great regions may be found minor areas to which some particular variety or strain is especially adapted. The semiarid region presents more of these localities than either of the others, as would be expected from its diversity of climate. On the northern Plains, 2-rowed varieties succeed better than 6-rowed. In northeastern Colorado, western Nebraska, western South Dakota, and western North Dakota, Hannchen has proved very dependable. This is a narrow, nodding, 2-rowed barley. Many of its awns fall off about ripening time. In Montana on dry land the White Smyrna variety is coming into favor. It is also grown some in Wyoming and in the Great Basin. It is a 2-rowed variety, extremely short strawed and with a very large grain. It is often cut with difficulty with a binder, but is harvested readily with a header. The first impression is almost always adverse to this variety, but its large yields and attractive grain are steadily extending its culture. In the irrigated sections of Montana and even South Dakota, the Chevalier is a favorite variety. A considerable quantity of this sort is grown in the Gallatin Valley of Montana. It is similar to the Hannchen, but it matures later and has a larger kernel. It is a favorite with the millers of pearled barley. Horn, a selection made by the United States Department of Agriculture, is similar to Chevalier. It has given higher yields and promises well on the dry lands of Wyoming and Montana as well as under irrigation. In Idaho, under irrigation almost any variety yields well. On account of the ease of culture, the 6-rowed types are the most common. Formerly Coast was widely grown, but it has been almost entirely replaced under irrigation by Trebi, a 6-rowed selection made by the United States Department of Agriculture which has produced very high yields. The Chevalier, White Smyrna, and Hannchen varieties are grown to a limited extent.

At high altitudes and in places of very low rainfall coupled with high temperature, hooded varieties are grown to some extent. At high altitudes the Nepal, a 6-rowed, hooded, naked, early variety is frequently grown. On the southern Plains and parts of Oregon and Washington small areas of Horsford are grown. This is similar to the Nepal, but hulled instead of naked. In parts of South Dakota, where hot dry weather comes on early and suddenly, early-maturing varieties are preferred. The Gatami has done well under such extreme conditions. It is a 6-rowed, awned, black-hulled variety.

In the Great Basin a winter variety known variously as Winter Club, White Club, or Utah Winter is occasionally grown. It is a dense, 6-rowed, awned, hulled variety.

In the humid-spring region there are no sharply defined local areas.

In Michigan a winter barley has been developed which is reported as promising by the Michigan Agricultural Experiment Station. The northeastern part of the region is well adapted to the production of the Hanna variety, but it has not yielded as well as the Manchuria in New York. Recently in New York, Alpha, a 2-rowed hybrid variety, has come into field culture and has given high yields. Featherston is the best variety of the Manchuria type.

In the humid-winter area the localities are classified on the presence or absence of barley rather than on the kinds of barley. The production is almost all in the mountain districts, although a small acreage is grown in the Piedmont area. The total production is small.

TABLE 5.—*Description and adaptation of the varieties of barley most frequently found in field culture*

Classification, variety, and synonyms [1]	Description					Region adapted	Area of special adaptation
	Kernel rows	Color [2]	Hulls	Awns	Spike		
Three principal type varieties:							
Coast	6	White	Hulled	Awned	Lax	Semiarid	
Manchuria and Oderbrucker (*Manshury*).	6	do	do	do	do	Humid spring	
Tennessee Winter	6	do	do	do	do	Humid winter	
Important minor varieties of less extensive distribution:							
Chevalier	2	do	do	do	do	Semiarid, irrigated.	Northern irrigated lands.
Horn	2	do	do	do	do	Semiarid	Montana and Wyoming.
Hannchen	2	do	do	do	do	do	Northern Plains and the West.
Alpha	2	do	do	do	do	Humid	New York State.
Club Mariout	6	do	do	do	Dense	Semiarid	California and the Great Basin.
White Smyrna	2	do	do	do	Lax	do	Montana and Wyoming.
Trebi	6	do	do	do	do	Semiarid, irrigated.	Great Basin.
Winter Club (*White Club, Utah Winter*).	6	do	do	do	Dense	Semiarid	Great Basin, fall seeding.
Less important minor varieties:							
Beldi Giant	6	do	do	do	Lax	do	About as Coast.
Gatami	6	Black	do	do	do	do	Severe summer conditions, northern Plains.
Hanna	2	White	do	do	do	Semiarid, humid spring.	
Himalaya (*Guy Mayle*).	6	Blue	Naked	do	do	Semiarid	Northern Plains.
Horsford (*Success, Beardless*).	6	White	Hulled	Hooded	do	do	Southern Plains.
Nepal (*White Hull-less, Beardless*).	6	do	Naked	do	do	Semiarid, humid spring.	Rocky Mountains.

[1] Synonyms are indicated by italic type in parentheses.

[2] In the hulled varieties the color refers to the glume only. Some of the white-hulled sorts have blue aleurone layers.

WHAT VARIETY TO GROW

In general it is best to grow one of the three standard commercial types, depending upon the region in which the grower lives. These types are the Coast, the Manchuria-Oderbrucker, and the Tennessee Winter. If the farm is located in a definite subdivision of one of these regions, varieties of such local adaptation should be used where seed is available. The most conspicuous cases of special adaptation are Alpha for New York State, Hannchen for the northern Great Plains, White Smyrna and Horn for the Montana dry lands, Chevalier for the Montana irrigated lands, Trebi for irrigated lands of the Great Basin, and Club Mariout in California. Spikes of four of these are shown in Figure 9. The State experiment stations should be consulted, as they are in a position to know the local variations which may determine the use of varieties. The character of the more important varieties may be seen in Table 5.

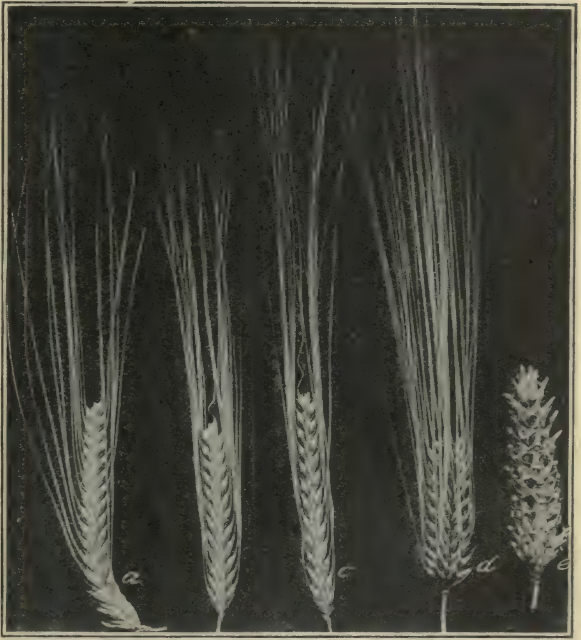

FIG. 9.—Spikes of five varieties of barley suited to areas in the arid region: *a*, Hannchen (Northern Plains and Great Basin); *b*, White Smyrna (Montana and bordering areas); *c*, Chevalier (irrigated and subirrigated lands); *d*, Club Mariout (late seeding in California and the Great Basin); *e*, Nepal (mountain districts and for hay)

WHERE TO PROCURE SEED

Seed should be obtained locally where possible. Seed of the three main types can be secured readily in any quantity through a large number of agencies. The Coast barley is handled by all grain dealers, elevators, and seedsmen of the West. The Manchuria and Oderbrucker are similarly handled in the northern Mississippi Valley. Many of the States have grain growers' associations which produce a better grade of seed, often of selected strains. These associations usually have a representative on the State experiment station staff from whom all information can be obtained. The Tennessee Winter barley is handled by southern seedsmen and by some grain dealers in the region of heaviest production.

The varieties of local adaptation are more difficult to secure. In most cases their culture is so recent that large lots of seed are not available. The Chevalier can be obtained in quantity in the Gallatin Valley of Montana, and considerable Hannchen has been distributed by the substations of South Dakota. There is a small production of White Smyrna in Montana, which so far has all been absorbed by local buyers of seed. Trebi is easily procured in southern Idaho, and there is a fair supply of Alpha in New York.

DISEASES

Barley is not commonly subject to heavy infections of diseases. Its freedom from rust accounts in part for the practice of seeding it on lands where the planting of spring wheat is delayed to the point of danger. Barley is not immune to rust, and very late seedings are sometimes damaged. There is generally a small percentage of loose smut in barley and a varying percentage of stripe diseases. The stripe diseases, according to recent studies, appear to be of greater importance than was formerly thought to be the case. They may eventually demand specific effort toward their prevention. At the present time only one barley disease is of clear-cut economic importance, for which recommendations of seed treatment are widely urged. This is the covered smut, which can be distinguished from the loose smut through the fact that the smut balls which displace the seed persist in the covered smut, but are broken up and dispersed by the wind before harvest in the loose smut. These smuts are shown in Figure 10. The importance of covered smut seems to vary inversely with the rainfall of the harvesting months. In the humid regions it is of only sporadic importance, the greater part of the fields escaping with unimportant losses. In the semiarid regions there is a gradual increase in infection, culminating in frequent heavy

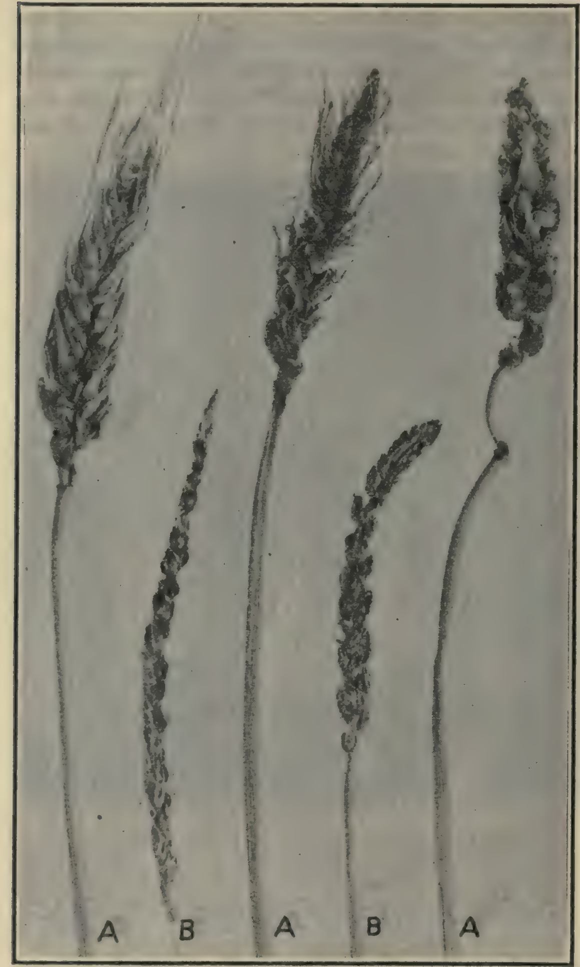

FIG. 10.—The covered and loose smuts of barley: *A*, Covered smut, in which the kernel is replaced by masses of spores, which are broken apart and mixed with the grain in threshing; *B*, loose smut, a form wherein the entire spikelet is replaced by a mass of spores, which upon maturity are scattered by the wind, leaving only the bare stems as evidence of the disease

losses in the Palouse district of Washington and Idaho and in parts of California.

Wherever the infection assumes any considerable importance, provision should be made for better conditions the following year. If clean seed can be obtained, it should be used. Clean seed is to be preferred to treated seed. If it can not be obtained, the seed should be treated with formaldehyde, 1 pound to 40 gallons of water.

The sprinkling method is not effective with the covered smut of barley. The method known as "soaking and skimming" is to be preferred. Place the solution in tubs or other containers and pour the grain in. Stir thoroughly. The stirring brings the smut balls to the surface, where they can be skimmed off. After skimming, remove the grain; pile and cover two to five hours with bags or canvas previously treated with formaldehyde. Make germination tests of treated seed to determine the extent of injury. Increase the quantity of seed per acre to cover injury and swelling. Although the danger of seed injury in barley is much less than in wheat, some farmers prefer to treat only a seed plat for the next year's stock. When this method is used, the seed plat should be treated annually.

When the clean or treated seed is finally available for seeding, care should be taken to avoid reinfection. The drill should be disinfected with the formaldehyde solution and used sacks avoided. If the crop of the following year is clean and suitable for seed, care should be taken that the threshing machine has not come directly from a field of smutty barley. If smutty barley was the last crop threshed, the machine should be disinfected as far as possible. The same precaution should be taken with respect to the bins and sacks. Keep the disease out by sanitary measures when possible; when not possible, treat the seed.

SUMMARY

The United States may be divided into three barley regions, which differ in economic, cultural, and varietal aspects—the semiarid, or western; the humid spring, or northeastern; and the humid winter, or southeastern.

In the semiarid region the Great Plains, the Great Basin, and the Pacific coast are well-defined subdivisions.

Barley is most profitable as a primary crop, but is a valuable secondary crop, as when it is used for late seeding in the spring-wheat region or to clean weedy fields.

The best barley lands are well-drained soils that are not sandy. Heavy loams are the best. Barley should not be seeded on poorly drained or light sandy lands.

Barley is a cool-weather plant. The best conditions of growth are found in early spring. In the humid regions, south of those sections where the summers are cool, early seeding is of vital importance.

Barnyard manures in the humid-spring region should be applied to the previous crop, as they induce lodging when applied to barley, The use of commercial fertilizers for barley is at present limited largely to the Eastern and Southern States.

Good seed of a good variety, well matured, well cleaned, and free from weed seeds and diseases, is an insurance that the crop starts without a handicap. A good seed bed will promote the initial growth.

Fall plowing in the humid-spring region, disked corn ground in the Great Plains, and summer fallow in regions west of the Rocky Mountains are the best methods of preparation.

Early seeding is necessary to obtain maximum returns. On the northern Plains the loss from seeding delayed beyond April 25 is more than 1 per cent a day.

In the humid sections 2 bushels are usually seeded. The rate decreases with the decrease in rainfall. In the driest sections 3 or 4 pecks is sufficient.

The depth of seeding varies from 1½ inches in the humid regions to 2½ or 3 inches in the Great Basin.

The best method of seeding is with the grain drill.

Barley should be mature when harvested, but should not be allowed to stand until the losses from shattering become important. The varieties of the humid region shatter more than those of the semi-arid regions.

The best method of harvesting is with the grain binder. The combined harvester is cheaper to operate, but the losses are greater.

Grain must be shocked and stacked, so as to suffer the least weather damage possible. Care should be taken in threshing that few kernels are broken. Close threshing decreases the market price of malting barley.

Barley is manufactured into malt, pearled barley, breakfast food, and flour. The malting trade demands a grain that is clean, plump; free from weather, bin, or threshing damage; and of high viability.

On account of its high acre yield barley should be more widely grown for stock feed. Through the Northern and Western States it should replace oats to a considerable extent. It may be fed whole, but is better rolled or coarse ground.

In present practice each of the three regions has a predominant type that succeeds well throughout that region. These are the Coast in the arid region, the Manchuria and Oderbrucker in the humid-spring region, and the Tennessee Winter in the humid-winter region. Of the less widely grown varieties, the Hannchen does well almost anywhere, but seems particularly adapted to the middle Plains. In Montana White Smyrna and Horn are superior. In the Great Basin, in addition to the Coast, the Club Mariout and Hannchen are promising. In California Coast and Club Mariout are the leading varieties. Under irrigation the Trebi in the Great Basin and the Chevalier in Montana are especially well adapted.

The covered smut is an important source of losses in the dry regions, especially in eastern Washington and Oregon.

Disease-free seed should be obtained, if possible. If this is not possible the seed should be treated.

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October 1, 1925

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1465

COTTON GINNING

1862 1889

THIS bulletin contains a general discussion of those mechanical processes of ginning which are important to farmers. Only saw gins are treated, as only a small part of the cotton crop is ginned by any other method.

The purpose is to bring to the attention of cotton producers, especially in those communities where cooperative handling and marketing of cotton is possible, the numerous benefits to be obtained by keeping the seed pure and by eliminating a portion of the losses caused by indifferent preparation of cotton for the market.

Special attention is called to the careless preparation of the American bale of cotton, the seeming indifference to this matter shown by the farmer, the buyer, and others handling it, and the losses arising from such indifference.

Washington, D. C.   Issued October, 1925

COTTON GINNING[1]

By G. S. Meloy

Assistant Chief Marketing Specialist, Bureau of Agricultural Economics

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SEPARATION OF SEED FOR PLANTING

One of the greatest difficulties in the production of cotton of uniform fiber is the inability of the planter to maintain the purity of the seed of the particular variety he prefers. He makes a practice of buying new seed every two or three years, as the contention is that seed "runs out" in this length of time—that is, his seed becomes so badly mixed, either at the gin or by cross breeding, that it no longer represents the variety originally planted. In the nature of things, different varieties of cotton become mixed if grown in adjacent localities because of the interchange of pollen.

Pure seed for planting purposes may be maintained by a proper system of seed selection,[2] which applies to all varieties of cotton. It is a good plan to pick planting seed from the lint by hand, so that it will not become mixed with seed from cotton of another variety; or, if so much seed is needed that this is impracticable, the cotton may be ginned in the regular way with good results if the ginner first takes the precaution to clean out thoroughly all the gin heads and to let the machinery run a few minutes so that all the seed and seed cotton from preceding bales will be removed. Particular care should be exerted to the end that the seed bin and trough are entirely free of any seed that may have been left from some other variety of cotton. In some gins the seed is not allowed to go into the seed bin, but by means of a board or piece of metal is conducted to the floor of the gin house, which should be swept clean before beginning the operation. This is by far the safer method. Some improved gins have a hinged metal chute which may be let down so that the seed discharged from the breasts will fall onto the floor instead of into the seed trough.

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[1] This bulletin is based on Farmers' Bulletin 764: Cotton Ginning Information for Farmers, by Fred Taylor, D. C. Griffith, and C. E. Atkinson. 1916.

Thomas H. Kearney, Seed Selection of Egyptian Cotton. U. S. Dept. of Agriculture, Bulletin No. 38. 1913.

[2] O. F. Cook. Cotton Selection on the Farm by the Characters of the Stalks, Leaves, and Bolls. U. S. Dept. of Agri., Bu. Plant Ind. Circ. 66, 1910.

If a large amount of selected seed is to be saved, the best results are obtained by ginning either very early in the season or after the rush of the season is over, when the ginner can take greater care in exercising the precautions that will maintain the purity of the seed. It is practically impossible to maintain the purity without the cooperation of the ginner, and it is unreasonable to ask him to delay his regular ginning work and keep other patrons waiting. Many ginners designate a certain day each week or certain days at the end of the season for the ginning of seed for planting. The manufacturers of ginning apparatus, in designing improvements, could well afford to give serious thought to the question of the quick and easy cleaning of the gins and the seed conveyors so as to encourage the use of selected planting seed. One solution of the planting seed problem possibly would be the installation of a small separate ginning unit. Such a gin might be set up in line with the battery of gins with the lint flue in direct connection but without connection with either the distributor or seed conveyor. During the regular ginning it could be thrown into gear and fed by hand with the seed cotton from which planting seed was desired, and the seed could be caught either in a box below or through a special chute directly into bags.

This care is necessary for the following reasons:[3] In the usual process of ginning, the seed roll, containing about 30 to 35 pounds of seed, is originally made from the seed of the first bale ginned. This seed roll fills the gin head, but the seed in it changes constantly and gradually. Thus each customer, after the first, receives the right quantity of seed, when he catches it in the seed bin; but the quantity is not made up entirely of the seed from his own cotton, some of that being left in the seed roll, to make up for that which he receives from the roll as originally formed. For any purpose other than for planting this is no detriment, but it is readily seen that seed obtained in this way may be composed of several varieties.

A most effective method of obviating this very serious defect in present methods can be used to advantage if each community will determine by experiment[4] the particular variety of cotton which is best suited to its section and agree to plant this variety only.

GINNER'S CERTIFICATE FOR THE FARMER

By driving a wagonload of seed or unginned cotton upon the scales, the gross weight may be determined. When the cotton has been ginned, the empty wagon is weighed. This second weight represents the tare, which is subtracted from the gross weight; the remainder represents the weight of the seed cotton with its impurities of dirt and trash:

---

[3] D. A. Saunders and P. V. Cardon. Custom Ginning as a Factor in Cottonseed Deterioration. U. S. Dept. of Agr., Bull. No. 288, 1915.

W. W. Ballard and C. B. Doyle. Cottonseed Mixing Increased by Modern Gin Equipment. U. S. Dept. Agr. Circ. 205, 1922.

[4] "Distribution of Cotton Seed in 1915." U. S. Dept. Agr., Bu. Plant Industry, Doc. No. 1163.

O. F. Cook. Cotton Improvement on a Community Basis. Yearbook, Dept. Agri., 1911.

	Pounds
Gross (weight of loaded wagon)	3,020
Tare (weight of empty wagon)	1,600
Net (weight of seed cotton)	1,420

Thus the customer can compare the ginner's weight of seed cotton with his original weight—that is, if he has weighed the cotton into his wagon. He can also calculate how the weight of his bale of cotton compares with the weight based on his estimate of the correct percentage of resulting lint. This percentage varies in different sections, as well as in different varieties of cotton, for the percentage of lint is merely the relation between the mass of the fiber and the mass of the seed. The size and weight of the seed and the quantity of fiber on the seed varies considerably in different varieties. Generally speaking it might be said that the smaller the seed the higher the percentage of lint, but it is also true that the smaller the seed the greater the number of bolls required to produce a bale of cotton. Some of the improved big-boll varieties run as high as 36 to 40 per cent of lint. On the other hand, small-boll varieties vary all the way from 25 to 45 per cent of lint, but the higher the lint percentage of the small-boll varieties the shorter and more abundant are the fibers on the seeds.[5]

A copy of a recommended weight certificate is here given. It gives all details from the time the wagon is first weighed until cotton and seed are ready for the market:

Driver______________________ Date______________________
On. Off.

JOHN DOE, Ginner

Owner ____

Seed cotton

Seed disposition______________ Gross______________________
Weight of seed______________ Tare (wagon)______________
Bale mark and No___________ Net________________________
Bale weight_________________ Weigher____________________

Name of driver should be written on line marked "Driver."

The words "On" and "Off" are used to show whether the driver was on or off his wagon when the load was weighed. If on, the word "Off" should be crossed out; if off, the word "On" should be crossed out. A weigher can not be expected to remember whether the driver was on or off the wagon when the load was weighed, and it is necessary to weigh the wagon the same way the second time in order to have the correct weight of seed cotton.

If seed is hauled from the gin by the customer the word "Out" should be written in the "Seed disposition" line. If seed is stored with ginner, "In" or "Stored" should be used. If sold to ginner, this space should be marked "Sold," followed by number of his check given in payment.

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[5] O. F. Cook. Danger in Judging Cotton Varieties by Lint Percentages. U. S. Dept. Agr., Bu. Plant Industry Circ. 11. 1908.

G. S. Meloy. Lint Percentage and Lint Index of Cotton and Methods of Determination. U. S. Dept. Agr. Bull. 644. 1918.

The line marked "Gross" shows the weight of the wagon and load. The line marked "Tare" shows the weight of the wagon after unloading the seed cotton. Subtracting the tare from the gross, the net weight of seed cotton is given, which should be inserted on the line marked "Net."

All other lines should be filled in as indicated.

The original of this certificate is made with perforated edge that it may be torn out and given to the customer. A duplicate certificate of a different color should be left in the book. Carbon sheets should be used in order that an exact copy may be kept by the ginner for his records, as an error is likely to occur if the duplicate is made in some other way. The use of carbon sheets will save labor and possible misunderstandings.

If the customer returns for the seed or sells it after it has been left in storage, the ginner should make proper notation on the original and duplicate certificates.

USUAL GINNING PROCESS

In the usual ginning process the seed cotton is fed into chutes by the elevator system, which takes the cotton out of the wagon by means of a suction fan. The cotton drops through the chute into the feeder and is then fed evenly to the gin saws, where the lint is separated from the seed.

The seed slides down to a trough from which, by a screw conveyor, it is carried to the seed pipe, thence to the seed bin or seed house. The transfer through the seed pipe to bin or seed house is effected either by a revolving screw conveyor or by the exhaust from the fan which furnishes the suction for unloading the cotton. When the screw conveyor is used, in the more up-to-date plants, the bottom of the seed trough is made of perforated metal which permits sand and dirt to be sifted out, thus improving the quality of the seed. If the customer wishes to retain his seed, he asks to have it conveyed into the seed bin, from which he takes it after his bale is ginned. When he wishes to sell or store it, it is conveyed into the seed house. The seed bin is situated in the gin yard between the ginhouse and the seed house, as with this arrangement the seed may be stopped at the seed bin or conveyed to the seed house by the use of valves in the seed pipe. When the seed is sold to the ginner or stored with him, it is not usually weighed, but a certain number of pounds are allowed. This amount usually ranges from 60 to 66 pounds per 100 pounds of seed cotton, the allowance being based on the average quantity of seed to 100 pounds of seed cotton in a given locality. The system of average percentages is, at best, inaccurate and unsatisfactory. An automatic weighing device is manufactured which can be set to weigh any small quantity of seed, the weight of a bushel being the usual amount. An automatic trip lets the seed into the seed pipe and registers the quantity on an indicator, which makes it possible for the ginner to pay each customer for his exact weight of seed. The trips of this indicator are carried forward automatically to another indicator which keeps the total number of trips through the season, and in this way affords the ginner an easy method of knowing the quantity of seed he has on hand. The first indicator is reset for each bale.

The lint cotton is passed from the gin saws through the lint flue to the condenser, which gives it a final cleaning and smooths it out into a bat or sheet. The lint is then dropped into the press box,[6] where it is pressed, wrapped, and tied, the size of the bale being usually 27 by 54 by 45 inches.[7] The bale is weighed, a certificate is given to each customer, and the bale is then ready for market.

ONE AND TWO STORY GINS

Most gins are of one or two stories. Each plan has some advantages. Without doubt a gin can be operated on the ground floor with less vibration, and therefore with less wear, tear, and friction, but with proper care and material a two-story gin can be built that will not vibrate to a great extent. Low fire risk, and therefore cheaper insurance, is one of the chief advantages of one-story gins with an earth or concrete floor. (Figs. 1 and 2.)

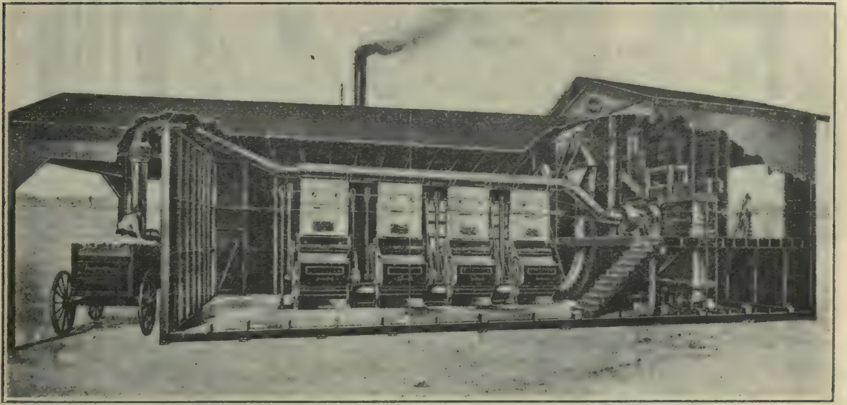

FIG. 1.—One-story gin, showing battery of four gin stands on the ground floor

PRINCIPAL PARTS OF GIN MACHINERY

ELEVATORS

Two distinct types of elevators are used on modern gins, the pneumatic elevator and the belt-distributor elevator.

The pneumatic elevator consists of two wooden or metallic pipes passing over a single gin or battery of gins (fig. 3). One is the air pipe, the other the cotton pipe. These pipes open at the bottom into chutes over the feeders. The cotton passage is separated from the air passage by a heavy wire screen. The suction in the air pipe causes the seed cotton to pass along the cotton pipe and drop into the chutes. When the chutes above the feeder become full, the cotton ceases to pass through the cotton pipe until a portion of the seed cotton is ginned out. When the air pressure is removed at regular intervals, the cotton is dropped to the feeders, then to the gin saws. The method of removing the air pressure varies with different makes of elevators (fig. 3).

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[6] A double press box is the one in most general use. When a bale is ginned into it the press box is revolved through an arc of 180° to be pressed.

[7] Twenty-seven by 54 inches is the standard size of the press box. The depth depends upon the density to which the bale is pressed, 45 inches being the usual dimension.

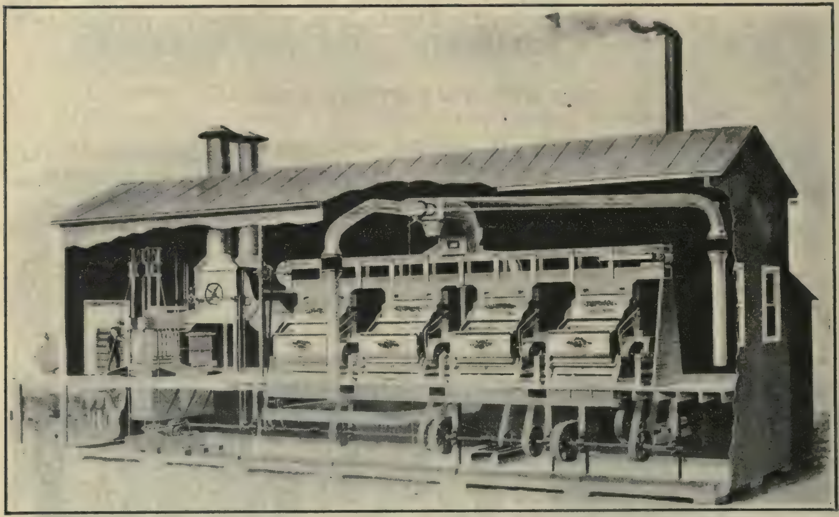


FIG. 2.—Two-story gin, with battery of four gin stands on second floor

The belt-distributor elevator consists of what is called a separator placed over a belt box through which passes a belt with projections or fingers placed thereon (fig. 4). A suction fan connected with the separator draws the cotton from the wagon into the separator, where it is thrown against a heavy wire screen, after which it is carried to the feeders by the belt distributor. When the feeders are filled, the surplus cotton is carried by the belt distributor to the end of the belt box and dropped onto the floor. This surplus cotton is called the "overflow."

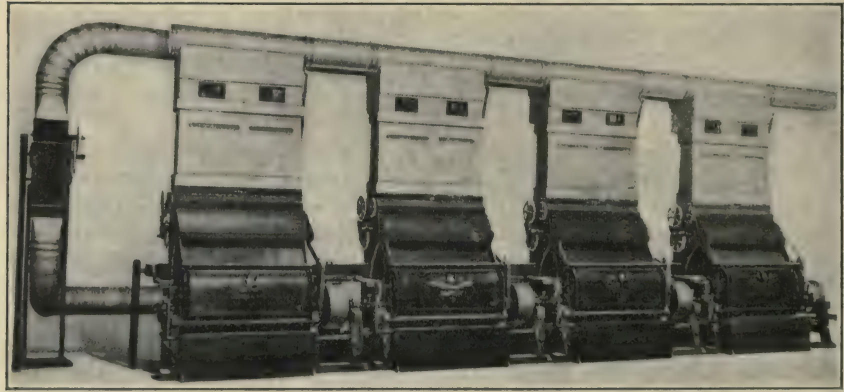


FIG. 3.—Pneumatic elevator over a battery of four gin stands

A large portion of the cotton going through the belt-distributor elevator goes to the overflow. When the cotton on the wagon is exhausted the suction is switched and the cotton from the overflow again passes through the separator and belt distributor. In this way it receives a double beating and cleaning before it goes to the feeder. It is a noticeable fact that the portion of the cotton which goes to the overflow and is again passed through the cleaning system is always of a better grade than that which passes through the machinery only once. When ginning his own cotton, a ginner frequently passes the entire load through the overflow and then rehandles the seed cotton before ginning. There is no doubt that it is profitable to do this, especially if the cotton is damp, as the quality is thereby improved.

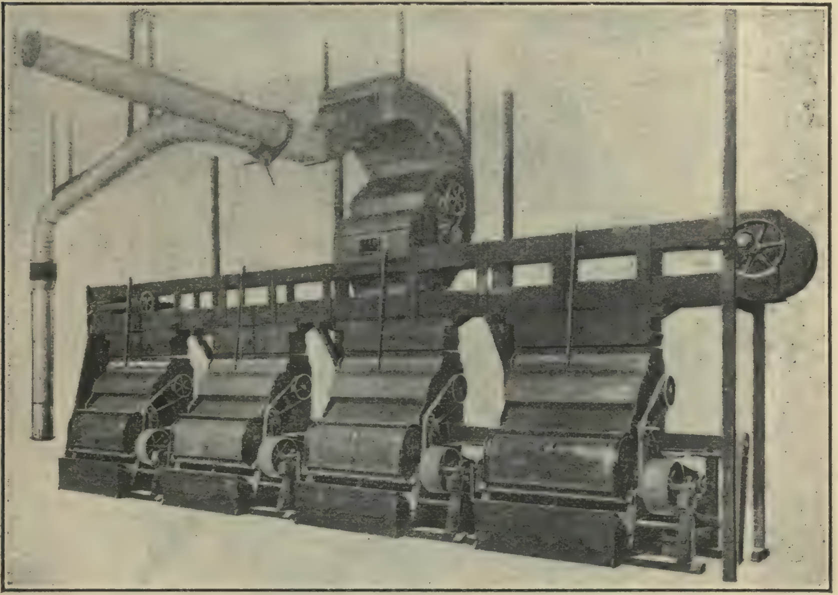


FIG. 4.—Belt-distributor elevator over a battery of four gin stands

PREPARATORY CLEANING PROCESSES

There are a number of bolly machines, boll extractors, boll breakers, beaters, cleaners, etc., which have for their object the separating of boll hulls, trash, and other foreign matter from the seed cotton before it reaches the gin saws. Some of these machines are separate devices through which the seed cotton is passed before reaching the feeders, others are built as a part of a cleaner feeder, and still others are combined with the separator. Frequently one gin plant makes use of several of these devices, passing the seed cotton through each in turn. Figures 5, 6, 7, 8, and 8A illustrate a number of the different kinds of machines.

These devices greatly improve the preparation of both cotton and cottonseed for the market. The removed boll hulls may be used for fuel, thus sometimes effecting a considerable saving.

CLEANER FEEDERS

Cleaner feeders are sold by every firm that manufactures cotton gins, the different makes being practically the same in mechanical principle. Cleaner feeders should be used by all ginners in preference to plain feeders without cleaner attachment, as by their use the quality of the cotton is improved materially. In the cleaner feeder the cotton passes through fluted rollers and over a rapidly revolving picker roller which is studded with spikes, thus beating the cotton vigorously and dragging it across a heavy wire screen. The greater

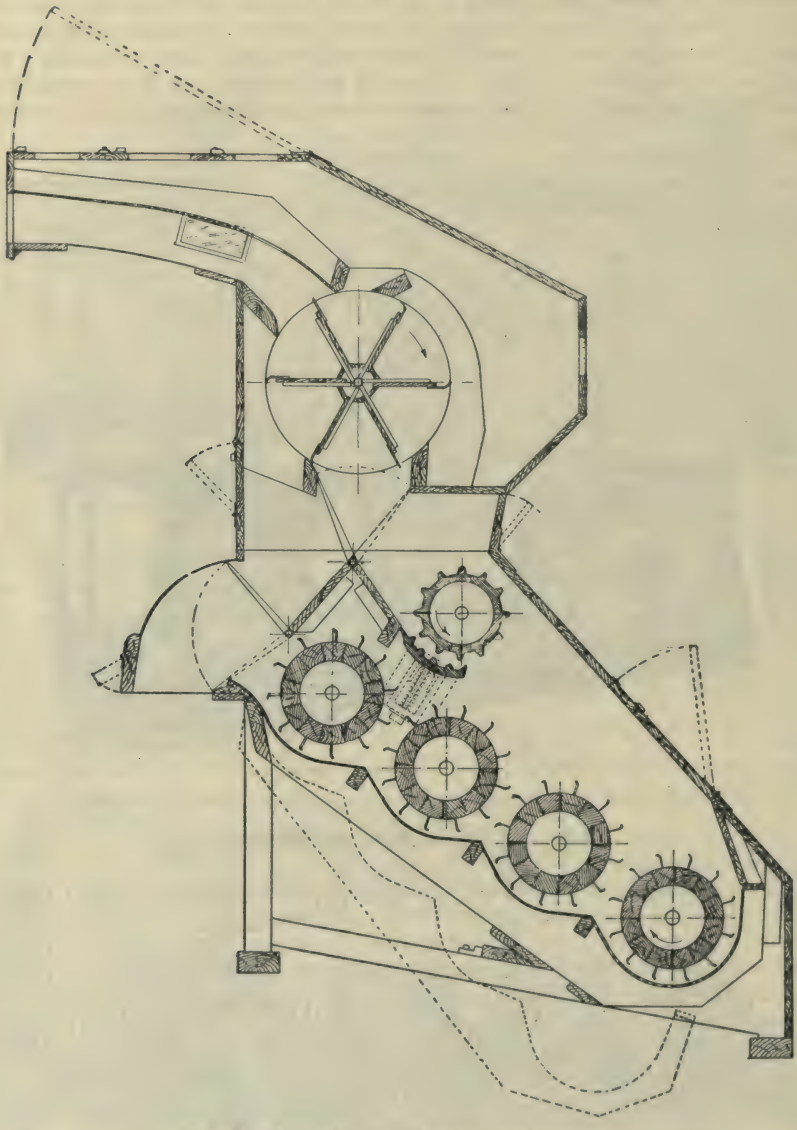


FIG. 5.—Separator, boll breaker, and cleaner

portion of the dirt and dust drops through this screen and is carried out by a screw conveyor. Figures 9 and 10 show working parts of two styles of cleaner feeders, and Figure 11 a cross section of another style.

GIN SAWS AND RIBS

The designs of the ribs of gins are different for plain, single-rib huller and double-rib huller breasts. Huller breasts have been used more commonly in those sections in which cotton is "gathered" rather than "picked." When cotton is "gathered," bolls, leaves, and trash are mixed with the seed cotton. A huller breast is required to eliminate these, which otherwise would be broken up and remain in the lint. Even in those sections where cotton is picked clean, the opinion is becoming prevalent that a huller breast is a good investment, since years in which the rotting of the bolls causes cotton of lower quality than usual come at uncertain intervals to every section.

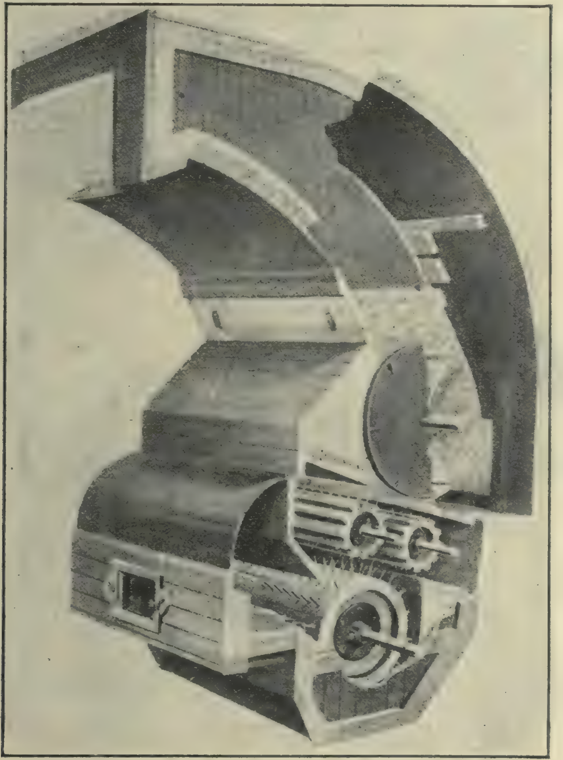


FIG. 6.—Combined cleaner and separator

COMPARISON OF 10 AND 12 INCH SAWS

Gin saws are made in two sizes, 10 and 12 inches in diameter. Saws 12 inches in diameter came into more general use with the development of the double-breasted huller gin. They have been found more efficient generally than the 10-inch saws because of their greater wearing surface. They have therefore largely supplanted the smaller size.

In ginning, the points of the saw teeth penetrate the mass of fibers. Some fibers are caught on the teeth and pulled off the seed. The fibers usually break off close to the seed coat. The fuzz which is left on Upland seed after ginning is not the ends of the long fibers, but is composed of a different type of fiber which is naturally short and resembles immature cotton. For good results each tooth should engage only a few fibers, and these should be removed from the teeth before they again come in contact with the unginned cotton. If the seed is damp or the roll too tight or hard, each tooth will take off too many fibers at a time. These may be so many as to be cut when drawn between the ribs, or, if wet, may stick to the saws and be returned through the roll several times, each time taking on more fibers until the lump is cut in passing between the ribs.

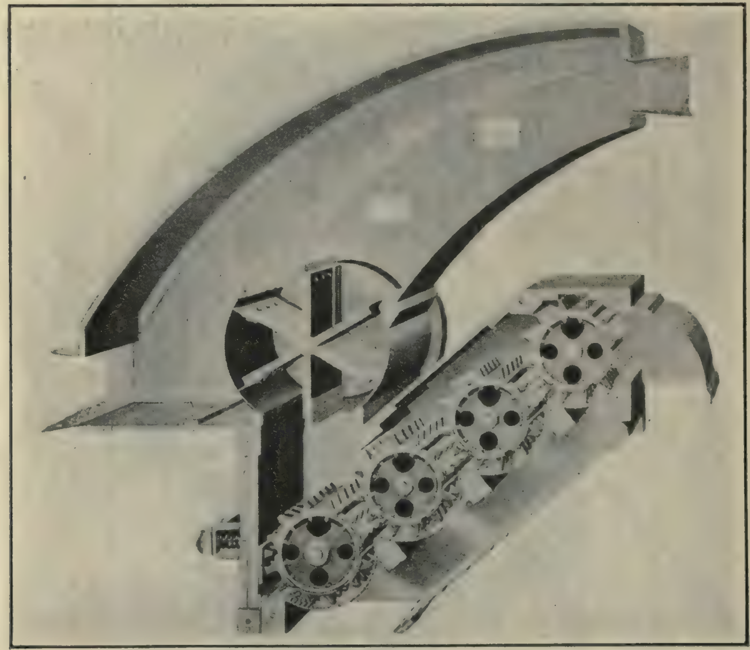
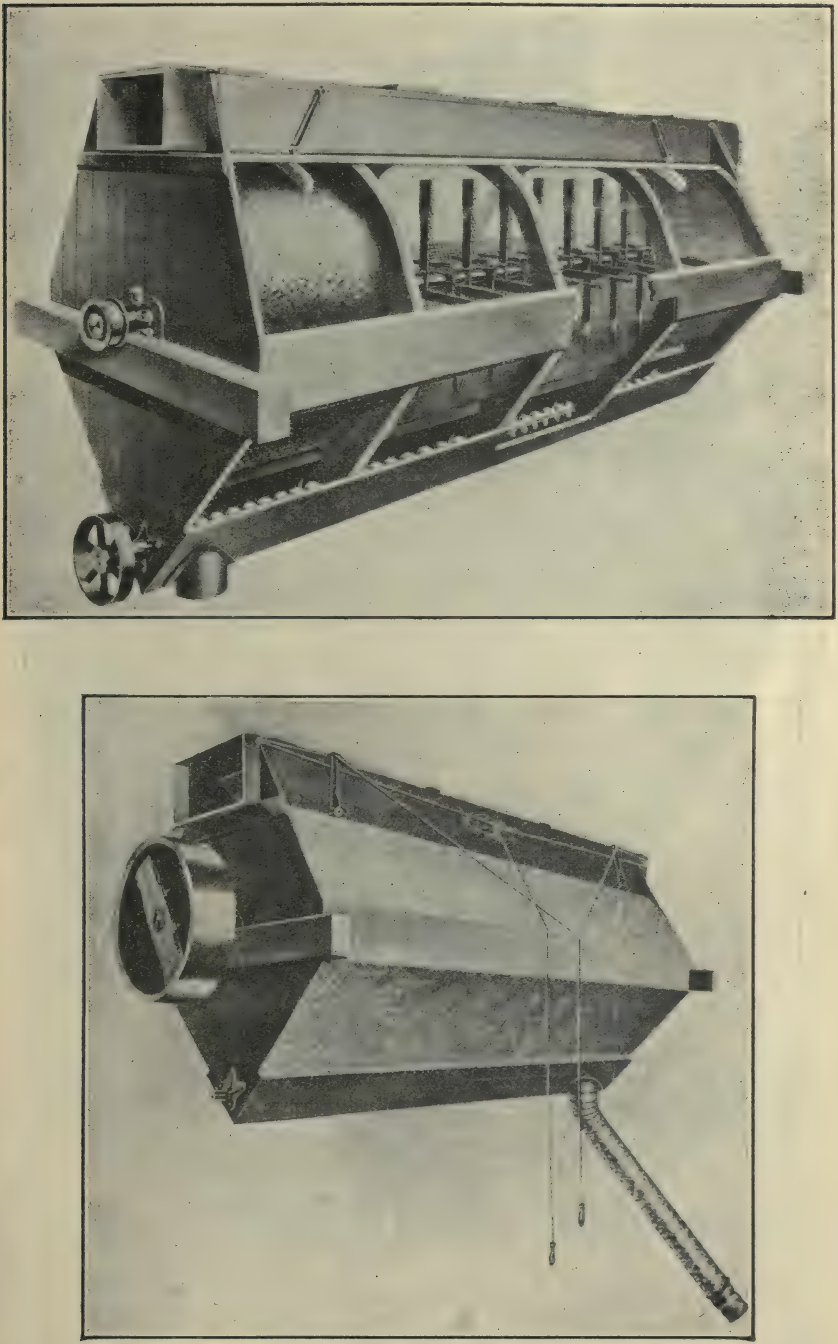
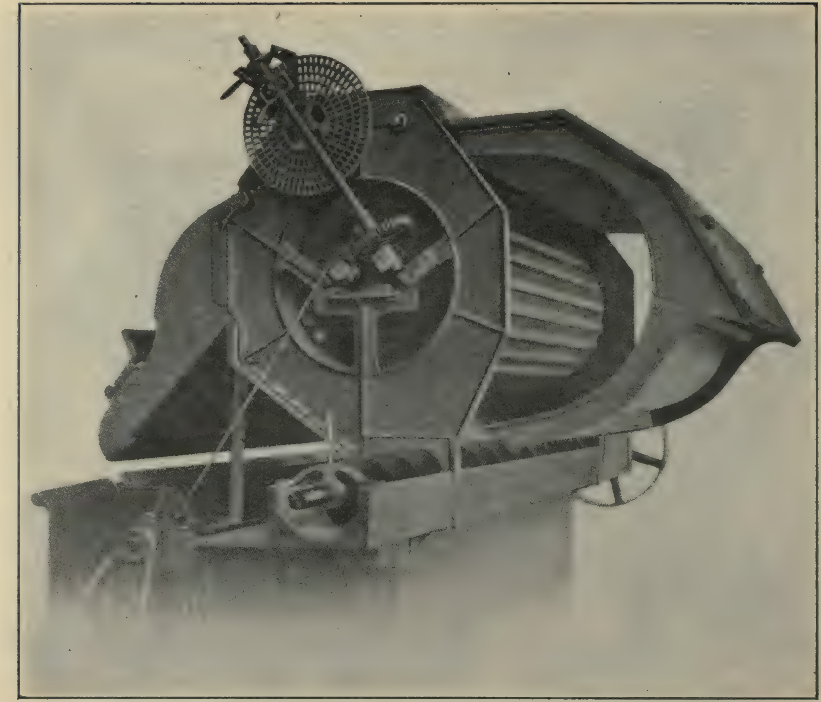


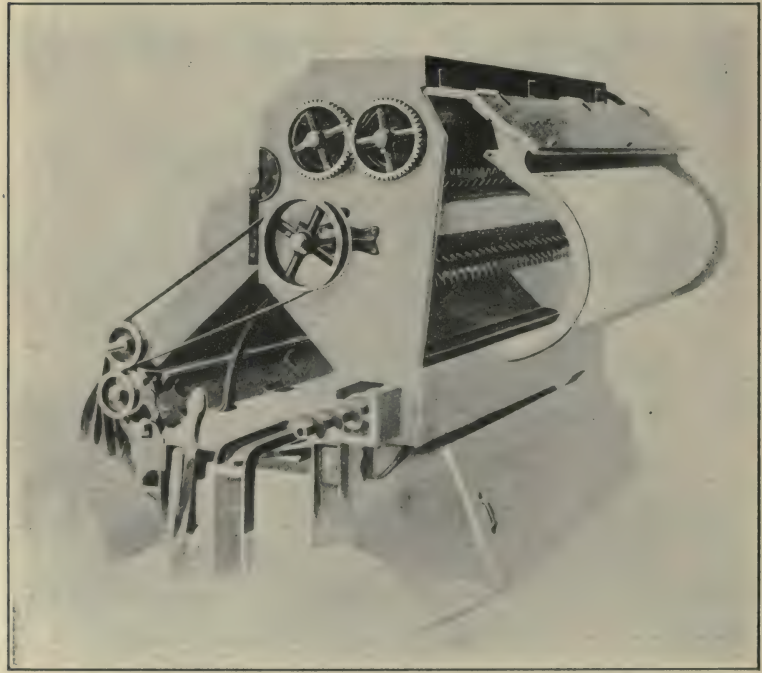
FIG. 7.—Combined cleaner and separator

Dull teeth do not penetrate between the fibers readily and are therefore likely to break them. Broken and bent teeth seriously damage the cotton. Gin saws should therefore be kept sharp and true. In sharpening, care should be taken to see that the original shape or pitch of the teeth is preserved, otherwise instead of sticking into the cotton between the fibers as originally designed their shape may be so changed as to cut the fibers seriously. The edges of the teeth should be smooth. Sharpening usually leaves the edges rough. Unless this roughness is dressed down it is likely to damage the



FIGS. 8 and 8A.—Two views showing a separate cleaner





FIGS. 9 and 10.—Views showing working parts of two styles of cleaner feeder cotton. Newly sharpened teeth will become smooth after two or three bales have been ginned.

For convenience and saving of time an extra saw cylinder is a good investment. These are interchangeable and should be kept sharp and in good condition at all times so they may be substituted as soon as needed.

Sand, dirt, stones, and other foreign matter in the seed cotton dull and damage the saws and cause excessive wear in other parts of the gin machinery. Cleaning devices, therefore, not only improve the grade of the cotton but prolong the life and reduce the upkeep of the gin outfit itself.

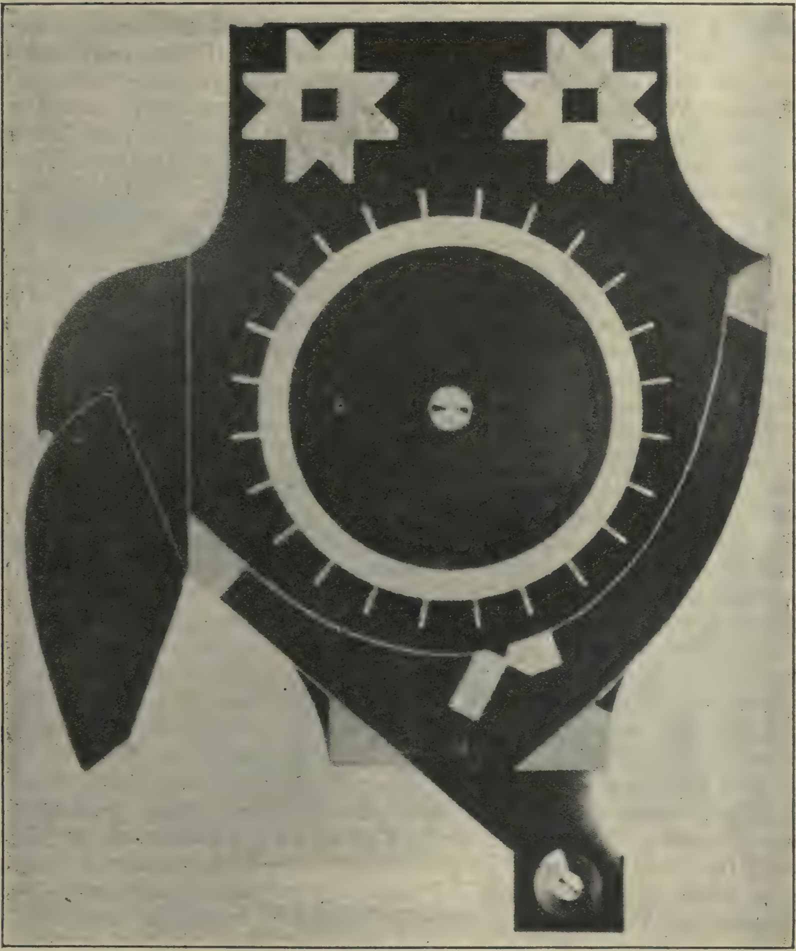


FIG. 11.—Sectional view of a cleaner feeder

SPEED OF GIN SAWS

Saws 12 inches in diameter have about 20 per cent more edge and teeth than saws 10 inches in diameter; therefore, at the same number of revolutions per minute, the teeth on 12-inch saws are moving farther and faster than the teeth on 10-inch saws. By "saw speed" is meant the speed of the teeth through the seed roll. This speed is limited by several conditions.

(1) The fibers must be removed from the teeth by the brush before the teeth come back into the roll. To do this, it has been found that the brush cylinder must revolve about three times as fast as the saws. Mechanically the speed of the brush is limited.

(2) The speed of the saws is limited by that rate at which the teeth become cutting rather than penetrating and pulling instruments. A disk of writing paper may be revolved fast enough to cut wood. Gin saws if given too great a speed will not only cut the fibers but will also cut seed that may come in contact with the edge of a saw. When seed are cut or damaged portions of the seed coat, often unginned or with much of the fiber still attached, pass between the ribs and into the lint and reduce the value of the cotton. Excessive saw speed also has a tendency to cut off some of the fuzz, which finds its way into the cotton, increasing the waste and reducing its value for spinning purposes.

(3) The length of the fibers also seems to limit the saw speed. The longer the fibers the slower the saws should be run and the softer the roll should be maintained. Probably the longer fibers are more tangled than the shorter fibers, so that a quick jerk will break them before they can slip out of the tangle.

For ginning cottons up to and including $1\frac{1}{16}$ inches in length of staple, under average conditions, a speed of about 400 revolutions per minute for 10-inch saws and 320 for 12-inch saws is recommended. The capacities of gins equipped with saws of these two diameters are approximately equal at these speeds. Often gins are "speeded up" in an effort to gain time, but the unfortunate result of speeding is to cut the fiber of the cotton to an extent which costs the producers a great amount of money each year.

Although the undue speeding of gins is discouraged, because of the injury to the fiber, it is realized that a large amount of education will be necessary to overcome the practice. Speeding of gin machinery is not a good economic principle from a ginner's standpoint. When a piece of machinery is run at a greater speed than was intended by the manufacturer, parts break, boxes run hot, belts slip, and any number of other accidents may happen which, through delays for repairs, will more than offset any advantage gained by a greater speed. The use of 12-inch saws and a reduction in speeds should result in a general improvement in the mechanical operation of the whole ginning plant. These suggestions are offered because it is realized that every reasonable method should be used for increasing capacities without damaging the fiber and that greater speeds are permissible under extraordinary conditions, such as might exist following a long, dry summer or open autumn.

AIR-BLAST AND BRUSH GINS

The lint is removed from the saws by two methods, the air-blast and the brush. The air blast is a comparatively new departure in gin manufacturing. The essential difference between the two types of gins is in the method of taking the cotton lint from the teeth of the saws. It has been claimed by some operators of the air-blast system that, in effect, the same principle is used by both methods, the mechanical construction being entirely different. In the air-blast method a fan is used to force a steady stream of air through an opening above the saw teeth, directly past the teeth into the lint flues, the stream of air having the same general effect as a brush. (See fig. 12.) The brush operates at a surface speed of about three times that of the saw tooth. Some contend that the speed of the brush bends the bristles back so that they just miss the gin saws; others maintain that the bristles touch the saws and exert both an air pressure and an actual contact which takes the cotton away (fig. 13).

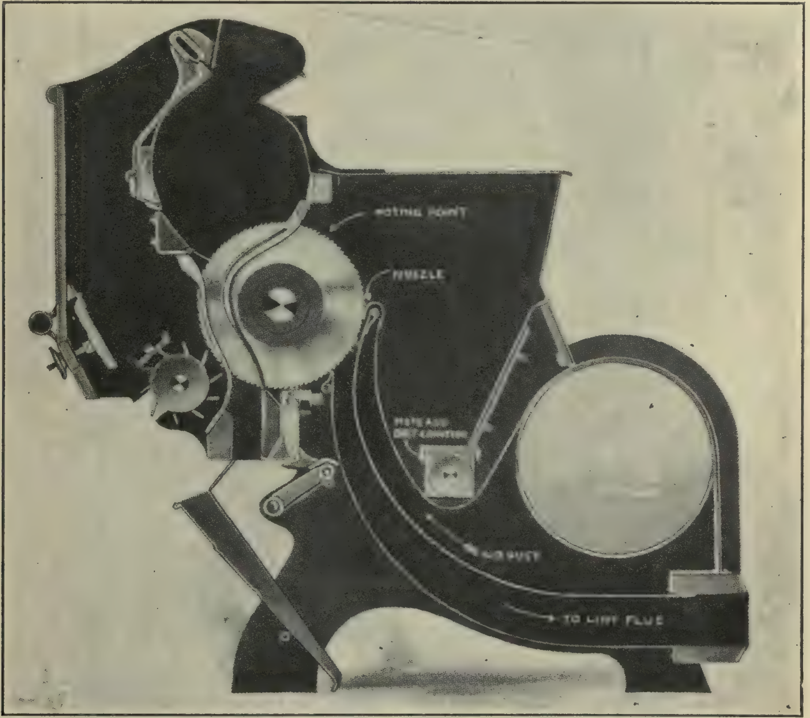


Fig. 12.—Double rib huller gin showing air-blast method of removing lint from saws

The force of the air blast is, of course, almost unlimited, so that the fibers can be removed from the saw teeth possibly more quickly than by the brush method. The quicker removal of the fibers from the saw teeth by the air blast probably will permit an increase in the saw speed, but this can be overdone by increasing the speed as indicated above to the point where the teeth become cutting rather than penetrating and pulling instruments. Manufacturers of air-blast systems of ginning are not yet a unit on the proper speed of the saws. Some makers claim 500 revolutions per minute as the maximum speed consistent with safety. Other makers insist that 750 revolutions per minute and even higher can be used without damage to the cotton. In all cases the proper saw speed will have to be determined by experiment and practical experience.

Possibly one of the chief mechanical advantages of the air-blast system is that it permits a construction which provides for better moting, a large section of the saws behind the ribs being exposed. This affords a maximum opportunity for motes and other heavy foreign matter to be thrown out by centrifugal force.

After the cotton fiber leaves the gin stand it passes through the lint flue to the condenser from which it passes to the press box. The cotton is pressed down from time to time during the ginning of a bale, either by hand or by a steam tramper. Frequently the packing around the piston becomes loose, allowing the condensed steam to drip on the cotton. This condition causes water-packed bales and results in an enormous annual loss. Such damage can be avoided by the use of mechanical trampers not requiring the use of steam (fig. 14).

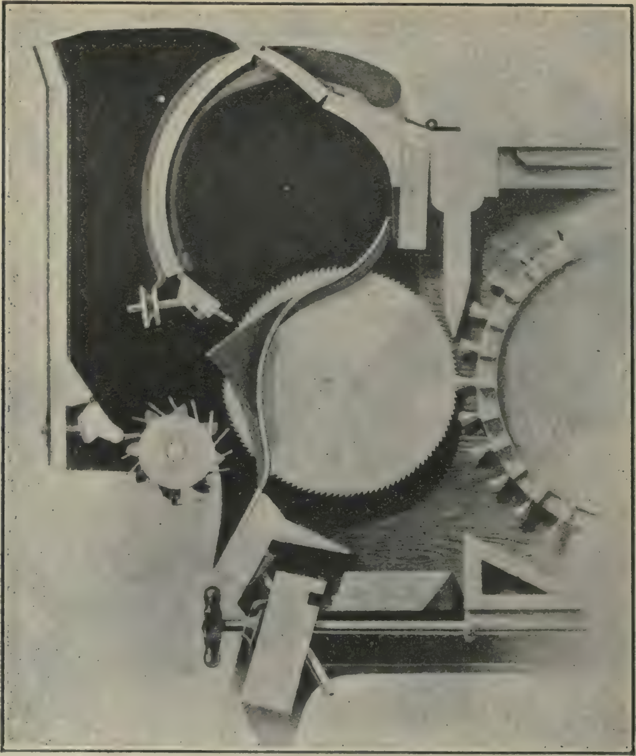


FIG. 13.—Single rib huller gin showing brush method of removing lint cotton from gin saws. Note brush placed in contact with gin saw

PRESSES

There are three methods of baling cotton—the screw press, the steam press, and the hydraulic press. The screw press is the one most frequently used, as it does the work well and is cheaper to install than either of the other two. It is very slow but is fast

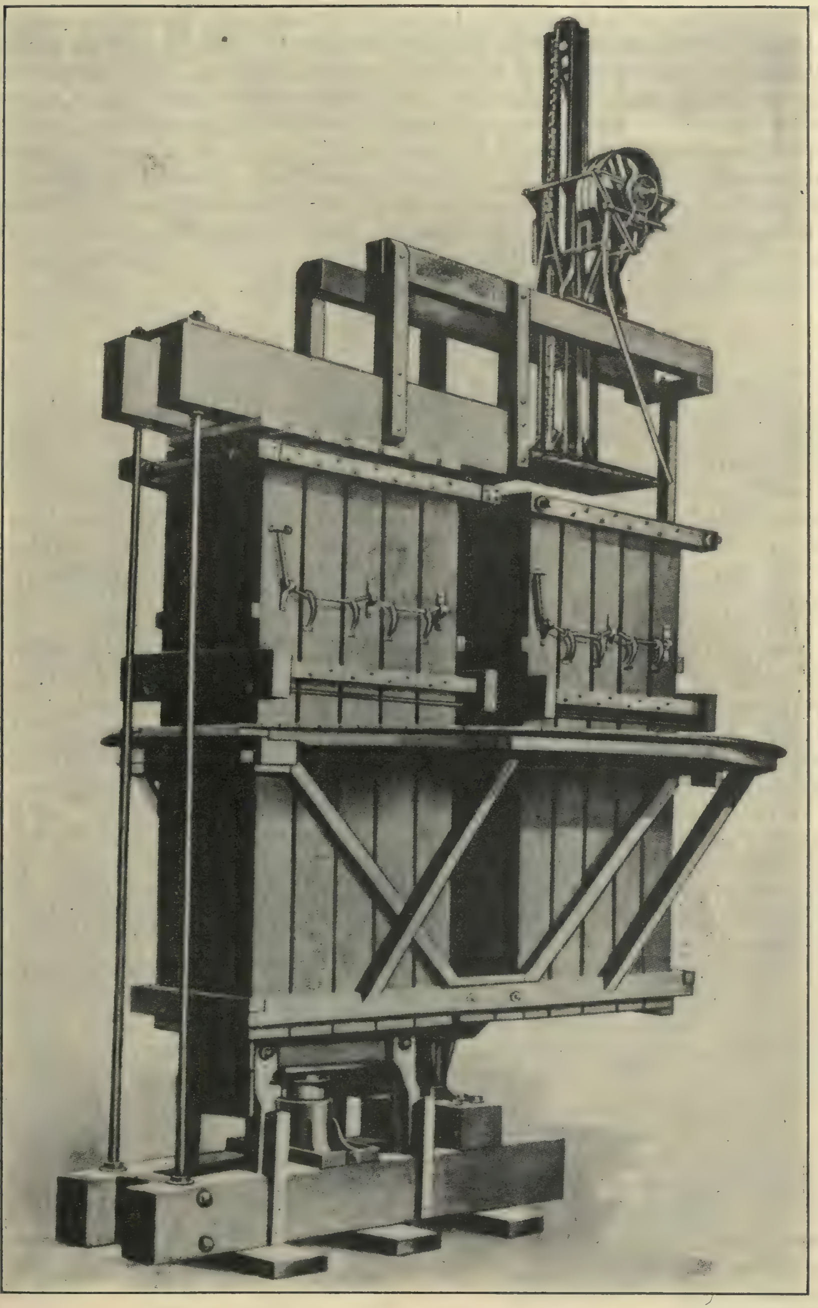


FIG. 14.—Double box press with belt-driven tramper

enough to take care of the cotton turned out by as many as five gins in one battery, as it is possible to "press and tie" a bale when the screw press is used as quickly as the following bale is ginned. However, it would seem that a quicker method would be profitable by saving a considerable part of one attendant's time. The steam press is very quick, and if it were not for the enormous quantity of steam consumed and consequent extra cost, it would be an ideal press. It is the most expensive kind to operate and requires a larger initial investment. The hydraulic press is the most powerful of all. It requires a hydraulic pump to operate, but the consumption of power is not great and a burden is removed from the engine, as compared with the screw press. Although not so quick as the steam press, it is desirable from other points of view.

TARE AND TYPE OF BALES

As the lint or fiber (or raw cotton) comes from the gin, it is put into packages of different sizes and shapes. The bulk of American cotton is packed into press boxes 54 inches long and 27 inches wide, to a depth of about 45 inches. This makes the usual "flat" or so-called "square" bale weighing about 500 pounds. This bale is sometimes called "a gin bale," "a plantation bale," "a farmer's bale," "a soft bale," or "an uncompressed bale." It is usually covered with 3 yards on the top and 3 yards on the bottom, of 2-pound jute bagging (wide mesh), making 12 pounds of bagging per bale, and is then tied with 6 ties, each weighing 1½ pounds, making a total tare of 21 pounds per bale. This is the standard tare that should be aimed at on all flat bales. If more bagging and ties are used in a community than trade rules permit, buyers calculate the excess tare in their price, and so sellers are not benefited as they may think they are. Excess tare is an economic waste, as it is unnecessary and its cost is borne by the bale itself, resulting in a loss to the farmer.

With the exception of the round or rather cylindrical bale and the recently devised gin-compressed square bale, described later on, the American ordinary square bale is of comparatively low density and is not only unwieldy but does not fit economically into either freight cars or the holds of ships. In order that the maximum number of pounds of cotton may be packed for shipment, flat bales are subjected to recompression by which the cotton is compressed to a higher density and the bale reduced to about half the first dimensions. Plants for recompressing the bales are usually located at all important markets and concentration points and are known as "compresses."

The average 500-pound bale as it comes from the gin has a density of only 12 to 15 pounds per cubic foot, and from 30 to 35 bales fill a 36-foot box car. When they are compressed to what is known as standard density compression, which means a density of 22½ pounds per cubic foot, then 65 to 75 bales may be loaded into a car; when pressed to what is known as high density compression, considered to be 32 to 34 pounds to the cubic foot, approximately 100 bales may be loaded into a 36-foot car.

Owing to the enormous quantity of cotton which it is necessary to handle in a short period of time at the large compresses, the bales are compressed very rapidly. The natural result is that some of the bands are tied shorter than others, and when the pressure is relieved, the bale expands slightly, exerting undue pressure on the shorter ties, often breaking either the ties or the buckles. Sometimes the ties are improperly fastened and fall off. It is not uncommon to see a compressed bale arrive at its destination with two or sometimes three ties missing, as is shown in Fig. 24.

Steamship companies penalize bales $1 each, that are ginned in press boxes of larger dimensions than 27 by 54 inches. Bales compressed to standard density naturally are a little wider and longer, as they expand during compression, the usual measurements for width and length being 30 inches and 57 to 59 inches, respectively, but as long as they come from gin boxes of the 27 by 54 inches dimensions, no penalties are assessed.

The average weight of the American bale is about 500 pounds, but the individual bales weigh anywhere from 300 to 700 or 800 pounds, more or less. Ginners should try to make bales as nearly 500 pounds as possible, as practically all cotton contracts are based on this weight per bale. Bales of much lighter weights cause buyers to penalize them for overtare, which again is an economic loss.

GIN COMPRESSES

In the western part of the Cotton Belt there are a number of gin compresses that make bales cylindrical in shape, but known as "round" bales. These are approximately 35 or 36 inches long and 20 to 22 inches in diameter, are completely covered with a closely woven bagging, known as burlap, and weigh from 250 to 270 pounds each. The bagging or tare is about 2½ to 3 pounds, or about 1 per cent of the gross weight, and covers the bale completely. No ties are used, as the cover is sewed on and this holds the bale without the use of ties. The density of round bales is usually about 29 to 32 pounds to the cubic foot.

There are also what are known as square, or rather rectangular, gin-compressed bales that are compressed to high density at the gin. These are particularly neat packages, one type of which measures 25 inches wide, 52 inches long, and 20 inches thick. The average tare on gin-compressed bales is 4 yards of 1-pound bagging and 7 ties. The tare on such bales varies with the type of the gin, but it is so much lighter than the tare on the ordinary square bale that the buyer can pay a correspondingly higher price. The savings are due to the difference in tare on gin-compressed bales, as compared with the tare on ordinary square bales, and to the fact that gin-compressed bales do not have to be recompressed.

The mechanical construction of a gin compress is in principle merely a very heavy reproduction of the ordinary hydraulic press. This form of compress is capable of producing a density equal to that of a railroad compress, so that shipments may be made direct to the domestic mills or for export.

Cotton that is compressed at the gin requires less material for covering, and the bale is wrapped completely, thus preventing some waste which occurs from a flat bale. It is also more fully protected from the ravages of weather and fire. Bales compressed at the gin arrive at their destination in better condition than do other compressed bales, as more care is taken in wrapping and tying them.

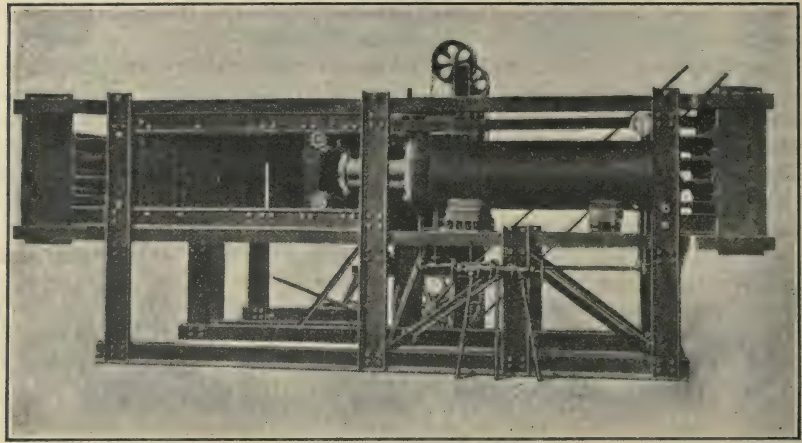


FIG. 15.—A type of gin compress

A study of the advantages of gin compression is well worth the time expended by any group of farmers who have for their object the cooperative handling and marketing of cotton. Figure 15 shows one type of gin compress. Figure 22 shows gin-compressed bales, and attention is directed to the neat and uniform package as compared with the common flat and compressed bale shown in Figure 21.

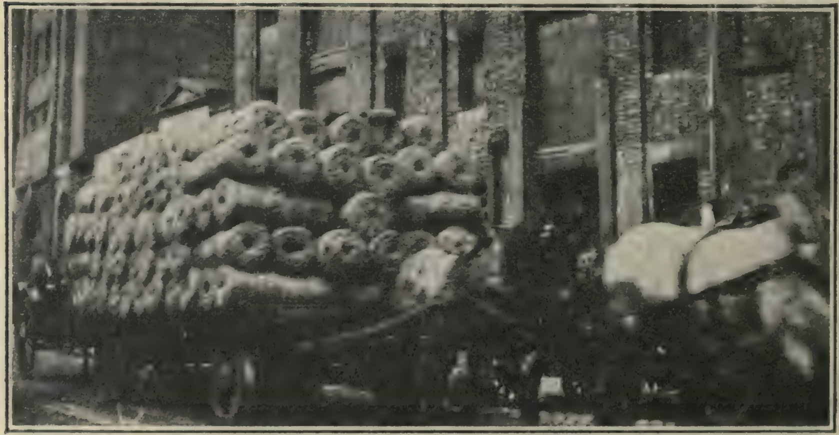


FIG. 16.—Rewoven bagging manufactured from the second-hand bagging taken from American cotton. This lot is in transit from warehouse in Manchester, England, to steamer, for shipment to Southern States, to be used again in wrapping American cotton. Use of this inferior bagging causes much waste that could be avoided by the use of better and more suitable covering

PLATED BALES

One of the most costly results of overcrowded gins is the "plated" bale. The ginner, in his anxiety to crowd the capacity of his gin, frequently does not allow a sufficient length of time for each wagonload of seed cotton to be ginned completely. He does not raise the breasts, and scarcely stops the feed long enough to judge accurately where one bale ends and a new bale begins. His estimate, ordinarily, is sufficiently correct, as far as the actual quantity of cotton is concerned, but in practice each bale gets a few pounds of lint from the preceding load, and in turn leaves a like quantity of cotton for the next bale. Thus the bales are not only plated, but, as the loads often are not of the same grade, the better cotton will be penalized down to the value of the lowest grade found, as the grade of a bale is determined by the lower side.

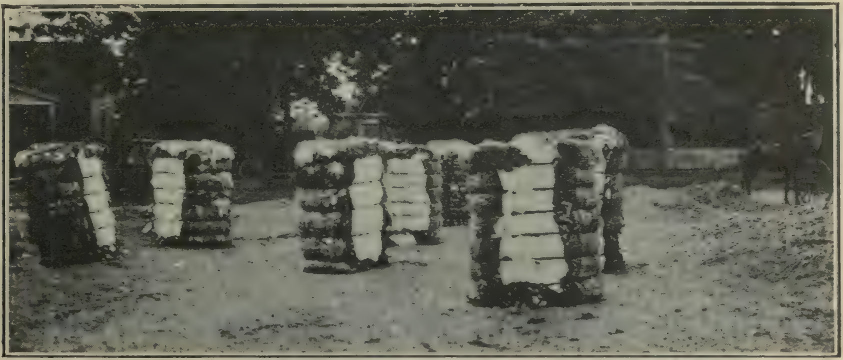


FIG. 17.—Cotton hauled back to the farmyard after ginning and left exposed to weather. Each bale is worth $100 or more and may deteriorate $5 per bale in value by becoming weather-beaten on the outside. This form of neglect is responsible for a great proportion of so-called country damage

GIN FIRES

Many gin fires are caused by matches that have been dropped in the seed cotton and that are ignited when coming in contact with the saws or other parts of the gin; but it has been demonstrated that by far the larger number are caused by sparks of static electricity generated by the operation of the machinery itself, especially on dry days. The presence of static electricity may be discovered easily by bringing a finger close to the lint flue or other parts of the ginning apparatus. A spark will be seen and felt to jump into the finger. If there is no outlet or grounding for this form of electricity it will store up until enough has been accumulated to overcome the resistance and it will then jump with a large, hot spark. Therefore, all parts—elevators, cleaners, feeders, gins, lint flues, etc.—should be thoroughly connected with the ground by suitable wiring (fig. 18). Insurance companies recognize the effectiveness of grounding and give better rates of insurance for gins that are properly grounded.[8]

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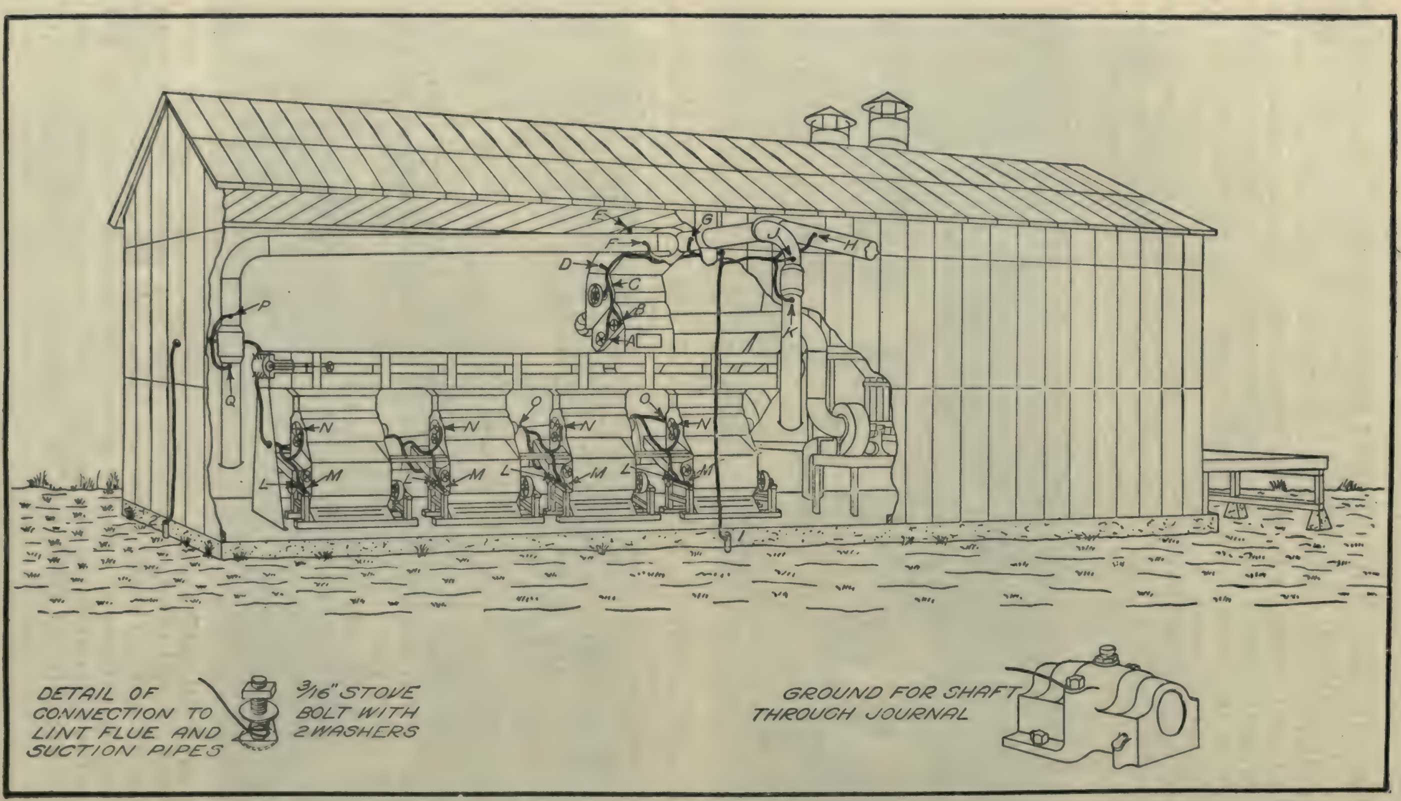
[8] H. E. Roethe. Grounding cotton gins to prevent fires. U. S. Dept. Agr., Circ. 271, 1923.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L
M
N
O
P
Q
DETAIL OF CONNECTION TO LINT FLUE AND SUCTION PIPES
3/16" STOVE BOLT WITH 2 WASHERS
GROUND FOR SHAFT THROUGH JOURNAL

FIG. 18.—Wiring system for grounding cotton gins

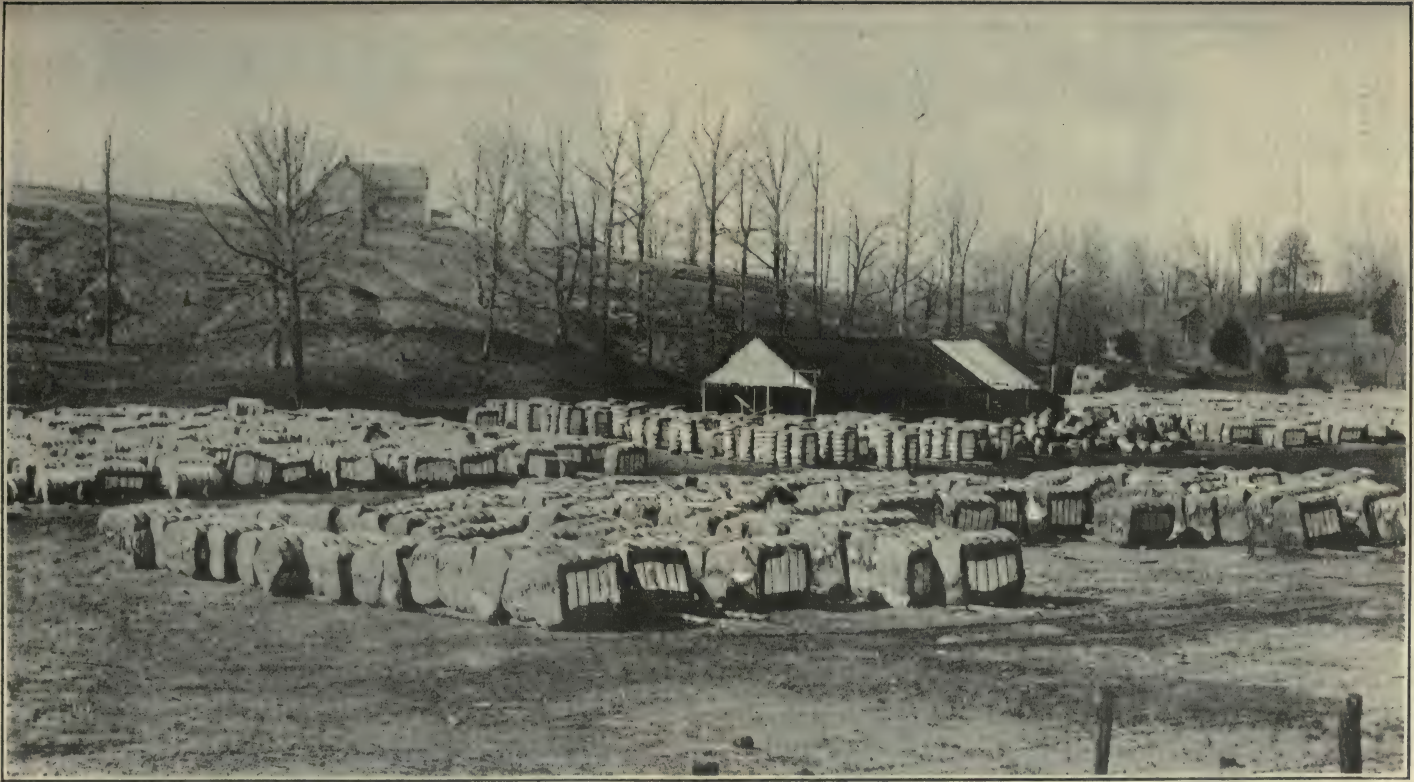

FIG. 19.—Cotton yard full of cotton resting on wooden poles. Practically every bale in this yard would be saturated with water following a heavy rain. Often these poles become moldy and rotten, causing decomposition of the cotton and resulting in considerable damage, depending upon the length of time cotton is left in this condition. Cotton "stored" in this way is turned occasionally, thus causing the other side of the bale to deteriorate in the same way. Cotton growers suffer much loss through this method of storing

CARELESS PREPARATION OF THE AMERICAN BALE

After cotton is ginned and baled it is often thrown into the gin yard or cotton yard (fig. 19), or perhaps hauled home and left exposed to the weather (fig. 17). The cotton sometimes becomes weather-beaten 2 or 3 inches deep on each edge. To ascertain the true grade, it is necessary to cut through this plate when the bale is sold. The bands have to be loosened and the outside plates taken off, or the price per pound paid for the whole bale will be influenced by

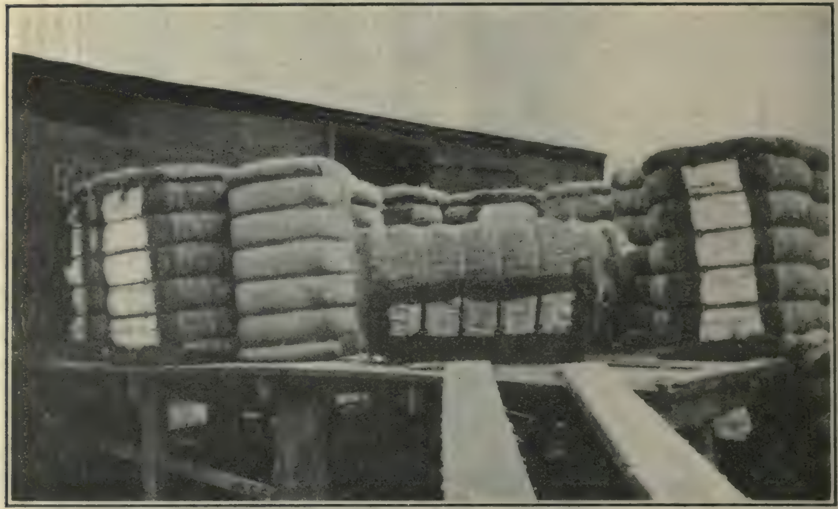

FIG. 20.—Railroad platform full of uncompressed cotton ready for loading on freight car, to be shipped to the compress

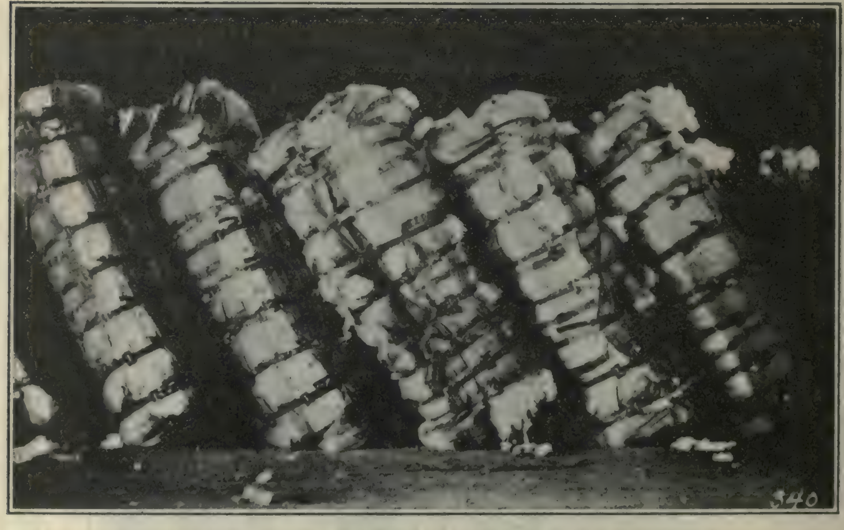

FIG. 21.—Appearance of American bales after being compressed.

the lower value of the outside plate. In either case an unnecessary loss is sustained. The better protected the cotton has been the easier it is to find a market, and the higher price it should bring. Cotton which has been picked carefully and stored while dry always finds a ready market in normal times, while no one cares to buy weather-beaten or damaged cotton unless it be penalized heavily. It is a well-known

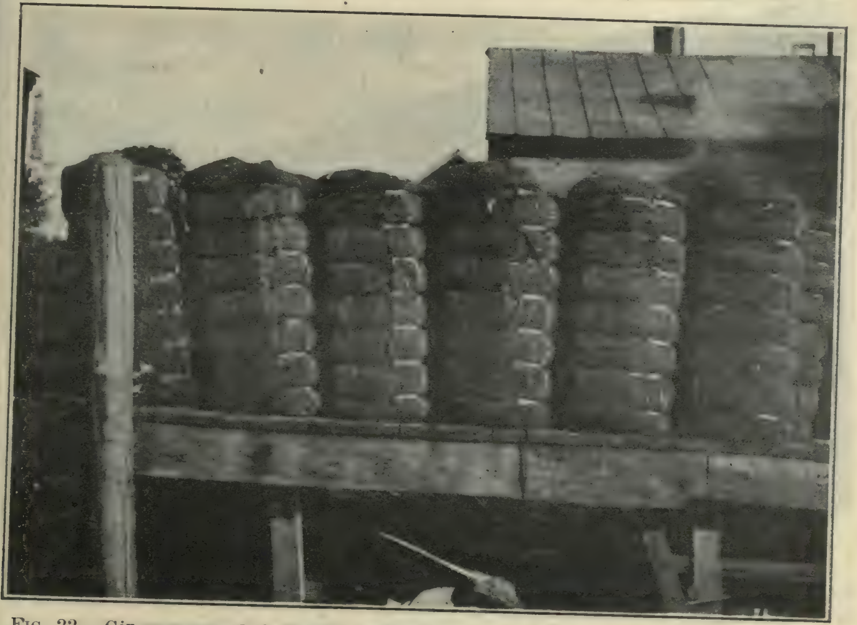

FIG. 22.—Gin-compressed bales on railroad platform ready for direct shipment to domestic mill or port. Note the neat, well-wrapped, and uniform package

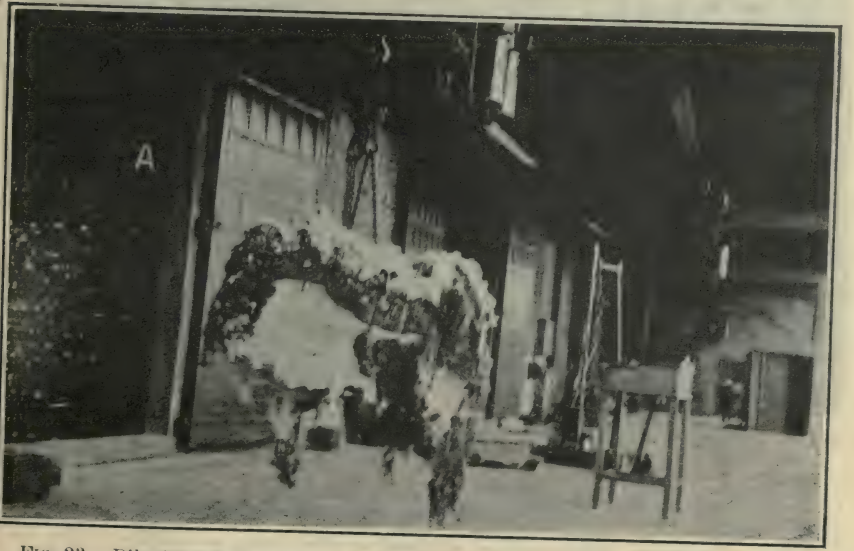

FIG. 23.—Dilapidated appearance of American cotton upon arrival at Manchester, England

fact that buyers must have a larger margin of profit on weather-beaten and damaged cotton on account of the greater risk incurred, as they are not always able to estimate the extent to which it has been damaged and the chances to resell it quickly are not so good, as there is not always a ready market for cotton of this character.

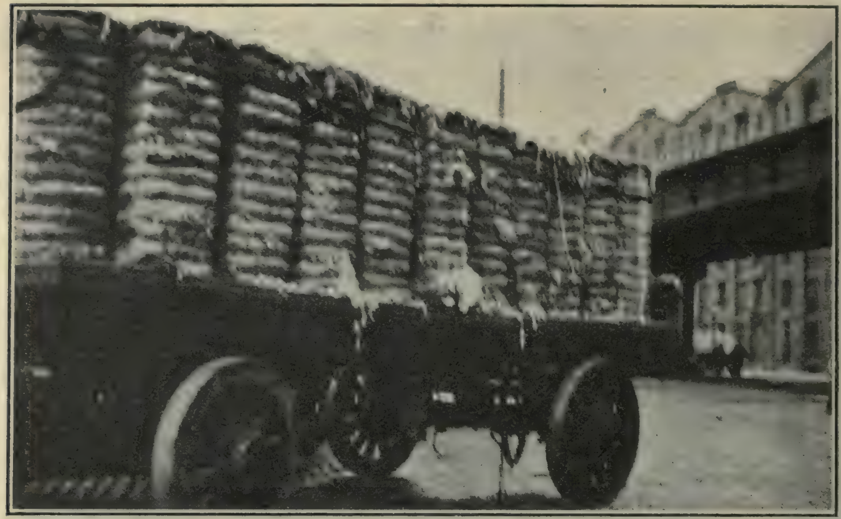

Fig. 24.—Appearance of Indian cotton on arrival at Liverpool, England

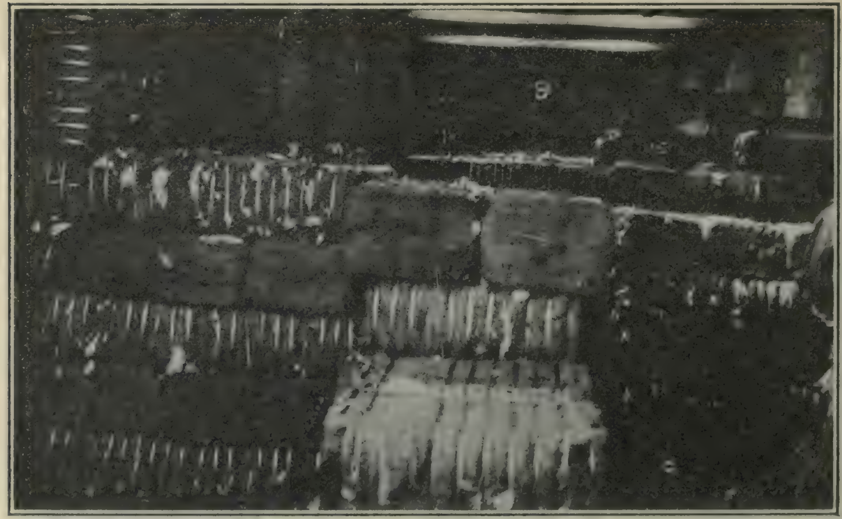

Fig. 25.—Egyptian cotton stored in warehouse at Manchester, England; capacity, 5,300 bales Egyptian cotton, average weight 750 pounds, or a total weight of 3,975,000 pounds. Capacity of these cotton safes, when stored with American cotton, is 3,500 bales, average weight 500 pounds, or a total weight of 1,750,000 pounds. If American cotton were compressed and covered in the same way as Egyptian, many thousands of dollars would be saved to the southern growers each year by reason of lower freight rates, reduced storage charges, and elimination of waste. No photograph of American cotton could be obtained at this place, as American bales are stored only when Egyptian or Indian cotton can not be obtained

No other agricultural product is so neglected as American cotton. Careless wrapping, sampling abuses, indifferent storage, and country damage all combine to illustrate in a most striking manner the utter disregard of consequences and the careless indifference which exists in the handling and marketing of this important and valuable crop. In no other case does a farmer care for his product from the time it is planted in the spring until it is harvested in the fall and then expose it to all kinds of weather and abuse. A comparison of the results of the present methods of handling the American cotton crop with the results obtained in the case of the Egyptian and Indian crops is best shown by Figures 16 to 25, inclusive. It is believed that it is possible to eliminate a part of the loss accruing to the farmer only by bringing to his attention the losses which occur from the time the cotton arrives at the gin until it reaches the mill, a large proportion of the expense of which is borne indirectly by him.

By concerted action the farmers should be able to establish better methods of ginning, maintain pure planting seed, and obtain more uniform and better handling of their cotton, thus enabling them to market their crops to better advantage.

It is to be hoped that the gin manufacturers will develop some device that will insure a quick and accurate method of keeping separate the products from each wagonload of seed cotton.

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AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT

Cotton Improvement Under Weevil Conditions. (Farmers' Bulletin 501.)
Cotton Anthracnose. (Farmers' Bulletin 555.) 5 cents.
Losses from Selling Cotton in the Seed. (Farmers' Bulletin 775.) 5 cents.
The Commercial Classification of American Cotton. (Dept. Circ. 278.)
Spinning Tests of Upland Long-Staple Cottons. (Department Bulletin 121.)
Economic Conditions in the Sea-Island Cotton Industry. (Department Bulletin 146.)
Cotton Warehouses: Storage Facilities now Available in the South. (Department Bulletin 216.) 5 cents.
Cotton Warehouse Construction. (Department Bulletin 277.)
Custom Ginning as a Factor in Cottonseed Deterioration. (Department Bulletin 288.) 5 cents.
Comparative Spinning Tests of the Different Grades of Arizona-Egyptian with Sea Island and Sakellaridis Egyptian Cottons. (Department Bulletin 359.) 5 cents.
Relation Between Primary Market Prices and Qualities of Cotton. (Department Bulletin 457.) 5 cents.
Handling and Marketing Durango Cotton in the Imperial Valley. (Department Bulletin 458.)
Extension of Cotton Production in California. (Department Bulletin 533.) 5 cents.
Improved Methods of Handling and Marketing Cotton. (Separate 605 from Yearbook 1912.) 5 cents.

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Marketing Cotton Seed for Planting Purposes. (Department Bulletin 1056.)
One Variety Communities. (Department Bulletin 1111.)
Improvement in Cotton Production. (Dept. Circular 200.)
Cottonseed Mixing Increased by Modern Gin Equipment. (Dept. Circular 205.)
Grounding Cotton Gins to Prevent Fires. (Department Circular 271.) 5 cents.
The Cotton Situation. (Separate 877 from Yearbook 1921.)

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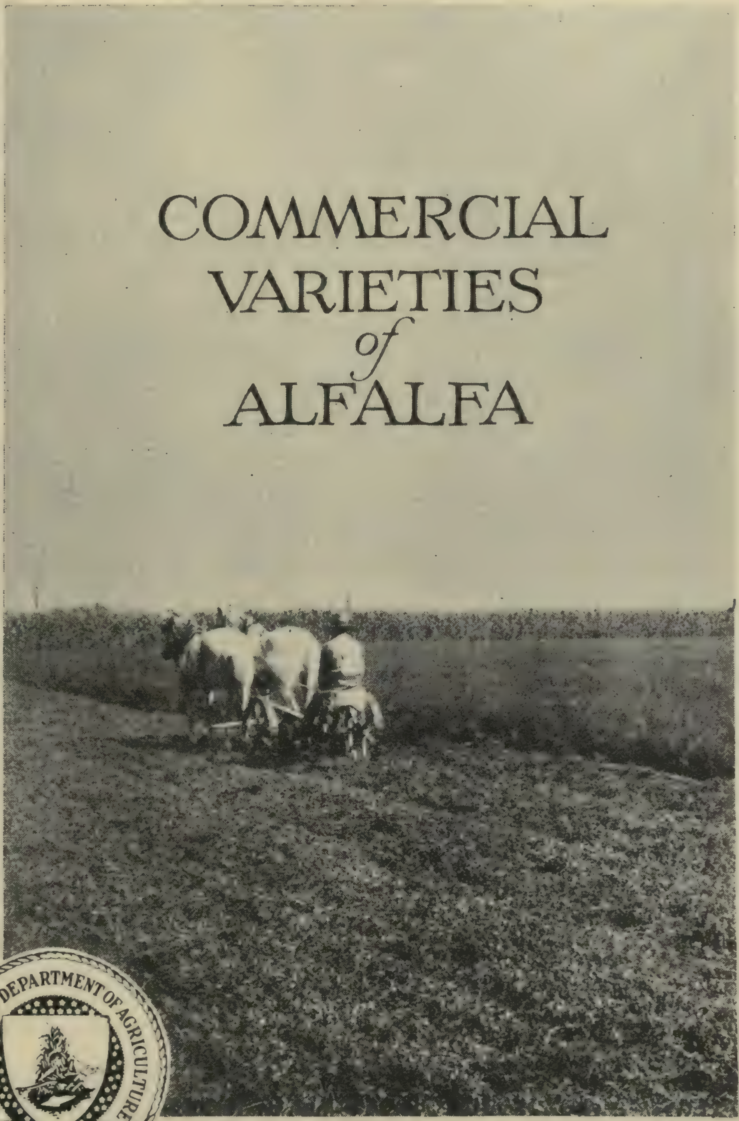
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1467

COMMERCIAL VARIETIES *of* ALFALFA



THE ALFALFAS of this country may be divided into five somewhat distinct groups: Common, Turkestan, variegated, nonhardy, and yellow flowered. These vary in their adaptation to climatic conditions and length of day, some giving the best results in the North and Northwest, whereas others succeed only in the South and Southwest.

Common alfalfa is a term that is used to include all of the alfalfas that are not clearly of hybrid origin or that do not have distinct and uniform varietal characteristics, such as the Peruvian and Arabian varieties. Numerous strains are recognized in the group, such as Kansas common, Dakota common, dry-land alfalfa, and irrigated alfalfa.

Indications are that Argentine and South African alfalfas are at least no hardier than Kansas common and therefore are not suitable for growing in our Northern States.

The commercial Turkestan alfalfa has been tested quite thoroughly in all parts of this country and in most cases has proved inferior to American-grown strains.

The Grimm variety is the most important of the variegated alfalfas. Other alfalfas in this group are Baltic, Cossack, and Canadian variegated. They have been found more resistant to cold than other commercial varieties or strains and are therefore recommended for sections where winterkilling occurs frequently.

In the nonhardy group, Peruvian alfalfa is the only variety that is commercially important in the United States. This variety comprises two distinct strains, the smooth Peruvian and the hairy Peruvian. These alfalfas are not resistant to cold and can be grown successfully only where the winter temperature is comparatively mild, as in the Southern and Southwestern States.

The alfalfas of the yellow-flowered group, sometimes referred to as Siberian alfalfa, rarely give more than one cutting of hay and produce seed very scantily. They are of comparatively little agronomic importance.

This bulletin is a revision of Farmers' Bulletin No. 757, which it supersedes.

Washington, D. C. Issued February, 1926

COMMERCIAL VARIETIES OF ALFALFA

By R. A. Oakley, *Senior Agronomist*, and H. L. Westover, *Associate Agronomist, Office of Forage-Crop Investigations, Bureau of Plant Industry*

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VARIETIES AND STRAINS OF ALFALFA

IT IS ONLY within the last 25 years that varieties of alfalfa have been recognized commercially in the United States, and only within the last 15 years have they been given really serious attention. Prior to 1898 no commercial distinction was made between the various lots of alfalfa seed sown in this country, whether they were of foreign or domestic origin. Coincident with the introduction of alfalfa into the various sections of the United States there developed an interest in varieties or strains for special conditions. This interest has resulted in the recognition and adoption of several fairly distinct commercial varieties and strains that show great diversity in their climatic and latitude relations. Some give the best results in the North and Northwest, where the winters are cold and the days are longer during the growing season than they are farther south; others do better in the extreme South and Southwest, where the winters are mild and the days during the growing season are relatively short.

These alfalfas have been produced mostly in nature, with almost no intentional effort on the part of man. The hybrid varieties are natural crosses, and the distinct types of pure origin are the products of natural selection. However, it is hoped that the results of the systematic plant breeding that has been conducted by the Department of Agriculture and the State agricultural experiment stations during the past decade will soon be available to the general public and that these efforts will produce strains or varieties of alfalfa that will be superior even to the best commercial ones that are now available. The present need is perhaps the greatest for alfalfas that will give profitable yields under the extreme conditions of moisture that exist, broadly speaking, in the West and in the East; that is, for the humid sections and for the semiarid sections, since in these sections the effort to extend the culture of alfalfa is the most active. Just what may develop in these regions from improved methods of cultivation and better adapted varieties can not be foretold.

The commercial alfalfas of this country may be divided into five somewhat distinct groups, each containing strains or varieties that vary considerably within themselves. These groups may be described briefly as follows:

The common group includes the ordinary purple-flowered smooth alfalfa, of which there are numerous regional strains generally grown throughout the western part of the United States and in foreign countries.

The Turkestan group includes alfalfas that have been developed in Turkestan. They differ from the common alfalfas of this country in that they are somewhat shorter and more spreading in habit of growth and are slightly more hairy. No commercial distinction is made between the various strains from Turkestan, all of them being sold under the name "Turkestan."

The variegated group includes the alfalfas that have originated from crosses between common alfalfa[1] and the yellow-flowered species.[2] The Grimm, Baltic, Cossack, Canadian variegated, and sand lucern are the best-known examples of this group.

The nonhardy group includes rather distinct varieties that are very susceptible to low temperatures. They are, in general, very erect in habit of growth, recover quickly after cutting, and have a long growing period. The Peruvian and Arabian varieties are members of this group.

The yellow-flowered group includes the various forms of the yellow-flowered species. They are easily distinguished from members of the other groups by their yellow flowers and crescent or sickle shaped pods.

In this bulletin the word "strain" is applied to alfalfas that are only slightly different from those that are typical of the ordinary purple-flowered alfalfa and also occasionally to alfalfas that belong to other groups, where they are considered with reference to these groups. The alfalfas of the common group that have developed in various regions are called "regional strains" and not "varieties," since they do not possess sufficiently distinct characters to be considered as varieties; on the other hand, the Grimm alfalfa, for example, which is referred to as a "variety" when considered in connection with the common alfalfas, may be spoken of properly as a "strain" of variegated alfalfa.

Lack of distinct differences in the seeds of the several varieties and strains, and also in many cases in the appearance of their vegetative growth, has made it difficult for farmers to recognize them readily and has resulted in much careless and unscrupulous dealing on the part of seed producers and seedsmen. There seems to be such a general lack of knowledge with regard to the characteristics of our commercial alfalfas and so much misinformation has been circulated, which has resulted in many cases in disappointment and financial loss, that it is believed an agronomic treatise on the varieties that have been generally advertised and more or less discussed in agricultural literature will be helpful at this time.

THE COMMON ALFALFA GROUP

Comparatively little is known with regard to the origin of common cultivated alfalfa, although there is good reason to believe that it developed in western Asia and was one of the first plants to be cultivated solely for forage. Since alfalfa naturally is an open-fertilized plant, it is difficult to determine just how many strains are included in what we now call "the common variety."

The alfalfa seed that was first sown in this country was introduced from various parts of Europe, but the stock from which most of the common alfalfa of our Western States has been produced was brought to Chile from Spain and after having been grown there for many years was introduced into California about 1850. In the Southwest this alfalfa is very generally known as Chilean alfalfa, but for lack of a better term in most other parts of the United States it has been designated as "common alfalfa." To be more specific, the term "common alfalfa" has been used to include all of the alfalfas that are not clearly of hybrid origin or that do not have fairly distinct and uniform varietal characteristics, even though within this group what are known as regional strains are coming to be recognized.

---

[1] *Medicago sativa.*

[2] *Medicago falcata.*

In most lots of common alfalfa there occur some plants that grow more quickly than others after being cut. These plants also have a tendency to produce somewhat heavier yields and differ from the others in general habit of growth. They are more erect and have comparatively small crowns, which are produced well above the surface of the ground. In contrast to these there are plants that are slightly procumbent in habit of growth and have comparatively broad crowns, which are produced somewhat below the surface of the ground. The plants of the first type are favored by mild climatic conditions, but succumb readily to severe winters. This type of plant is sometimes referred to for convenience as the "southern or nonhardy type." Plants of the second type are hardy and predominate as a result of the elimination of the more tender individuals in strains that have been developed in cold climates. This particular type is often referred to as the "northern or hardy type." These two types of plants furnish a basis for the development of regional strains, which, as they are at present defined, are produced when common alfalfa is grown for several seed generations in definite localities where eliminating conditions of one kind or another normally prevail.

To illustrate what is meant by "seed generation," the seed produced from the original sowing may be said to be the first seed generation. If this be sown and seed produced from it, such seed would represent the second seed generation, and if this practice is continued for a considerable number of generations under eliminating conditions it will have a tendency to produce a fairly distinct strain of alfalfa. A difference is now being recognized between lots of alfalfa that have been grown for several seed generations in the various States. To such lots names of the States or terms descriptive of the conditions under which they were produced are sometimes applied, as, for example, Kansas-grown alfalfa, Montana-grown alfalfa, irrigated alfalfa, dry-land alfalfa, and many others. Certain regional strains produced in foreign countries are also recognized.

DOMESTIC STRAINS

The names "Kansas-grown" and "Montana-grown," as used in the general seed trade, are not necessarily distinctive. The mere fact that a certain lot of alfalfa seed was grown in Kansas or Montana is of no importance unless such lots of seed were produced as a result of several seed generations grown in those States. The same is true of seed called in the trade "dry-land," "irrigated," and "nonirrigated" alfalfa, and it is safe to say that much undue discrimination has developed in connection with its sale. Just how many seed generations are required before a variety growing in one locality assumes rather definite characteristics doubtless varies with the nature of the eliminating climatic conditions and can not be estimated accurately. Fortunately, much of the seed which is grown in each section that produces seed with a fair degree of consistency has come from stock that has been grown in that section for several seed generations. However, it is always well for a prospective purchaser to investigate this point if possible. The history of seed advertised as "dry-land" or "nonirrigated" should be investigated very carefully before purchasing if a price materially above the prevailing price for ordinary seed is asked, inasmuch as the history of such seed is often very uncertain.

The so-called regional strains produced in Kansas, Oklahoma, and other States having similar conditions have a tendency to recover more quickly after cutting and to give better yields than strains produced farther north. This characteristic has apparently been the result of latitude and climatic conditions favoring the perpetuation of the more rapid-growing and high-yielding individuals, until a strain is produced that has these characteristics to a rather definite degree. The regional strains from the above sources, therefore, are recommended in sections having a similar latitude where the winterkilling of alfalfa normally is not a serious factor. (Fig. 1.)

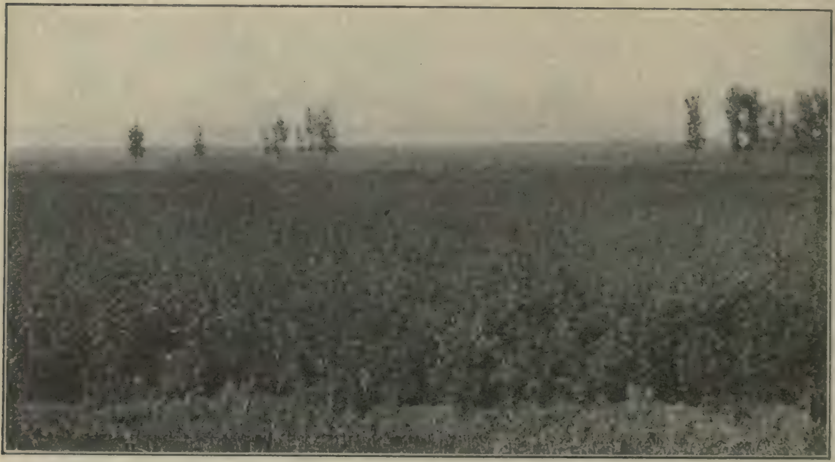

FIG. 1.—A field of common alfalfa from Kansas-grown seed

The common alfalfa grown west of the Rocky Mountains is very similar in its characteristics to that grown in Kansas, Oklahoma, and Texas, and careful tests show that it gives approximately the same results in sections having comparatively mild winters. In general, however, alfalfa seed from west of the Rocky Mountains has not proved quite so hardy as that grown in the same latitude on the Great Plains. Where winterkilling occurs with a considerable degree of frequency, the strains of alfalfa developed in the Northern States are preferable to those produced farther south. Regional strains from northern Nebraska, the Dakotas, and Montana are at least somewhat hardier than those developed in Kansas, Oklahoma, and Texas, or the intermountain region, owing, presumably, to the fact that the severe winters of the North have effected the elimination of a great many of the tender individual plants. These northern strains of common alfalfa are seemingly less productive at lower latitudes than those from the South, but their tendency toward greater hardiness and their apparent ability to produce higher yields in the North make their use advisable for sowing there.

It is reasonable to assume that where alfalfa is grown under conditions of scant moisture there is some elimination of the less drought-resistant individuals and that if elimination continues throughout a large number of generations a strain superior in drought resistance must necessarily result, just as comparatively hardy strains have developed, for example, in the Dakotas and Montana. It must be admitted, however, that the tests conducted by the United States Department of Agriculture and the results of those published by State agricultural experiment stations have not revealed a materially superior drought resistance of dry-land-grown alfalfa over the common alfalfa grown either under irrigation or where rainfall is fairly abundant. The probable explanation is that the lots which were tested had not come from a sufficiently large number of seed generations grown under conditions of scant moisture. It is very doubtful whether much of the seed offered upon the market as " dry-land " or " nonirrigated " is in the least degree superior to that grown under irrigation or in the so-called rain belt.

PROVENCE STRAIN

Provence is the name that is applied to a strain of alfalfa grown in southwestern France. According to the definition formulated at the beginning of this bulletin, it is classed as a regional strain of common alfalfa and not as a distinct variety. It was doubtless introduced into this country at an early date, but there is no record of its introduction under the name of Provence until 1898, when the Department of Agriculture procured a small quantity of seed for testing. It was apparently shortly after this date that the name was used commercially and the seed received limited recognition by the seed trade.

The Provence strain differs so slightly in general appearance from the common regional strain from Kansas that one can scarcely be distinguished from the other. There are, however, a few differences of some importance. The Provence commences growth earlier in the spring and continues to grow later in the fall in the southern part of the United States than does the strain from Kansas. It also makes somewhat quicker growth after cutting. However, it is not quite so hardy and can not be recommended generally north of the central part of the United States.

Although the true Provence strain is an excellent one for sections in which severe winters do not occur, it is not commercially important in this country.

ARGENTINE ALFALFA

In recent years a large part of the alfalfa seed that has been received from foreign sources has come from Argentina. Practically all the alfalfa grown in that country belongs to the common group. Several more or less distinct strains have developed, as a result of having been grown under widely varying conditions of climate and latitude. Most of the seed that reaches the United States is produced south of Buenos Aires, but the climatic conditions there are much less severe than for a similar latitude in this country and therefore not conducive to the development of a hardy strain. It should be remembered that the seasons for Argentina are the reverse of ours. Our climate becomes warmer southward; theirs becomes warmer northward. The tests that have thus far been conducted in the United States indicate that the hardiest strain of Argentine alfalfa is no hardier than our Kansas common alfalfa. For this reason the prospective grower should play safe and sow it no farther north than Kansas alfalfa is known to succeed. In the southwestern part of the United States some strains of Argentine alfalfa compare very favorably with the local-grown common.

SOUTH AFRICAN ALFALFA

During the past few years enough alfalfa seed from South Africa has reached the United States to stimulate a few inquiries regarding its suitability for this country. As the most southerly point of Africa is no farther south of the Equator than the southern line of Tennessee is north of the Equator, it is evident that the climatic conditions have not been conducive to the development of a hardy alfalfa. The preliminary tests conducted in the United States with alfalfa from South Africa show some variation, but the indications are that the commercial lots are of the common variety and can not be grown with safety quite so far north as our Kansas common alfalfa. Farther south South African alfalfa probably will compare favorably with local strains of common alfalfa.

TURKESTAN GROUP

Ever since 1898, when the Department of Agriculture introduced several lots of alfalfa seed from Turkestan, all of the commercial seed coming from that country has been classed under the name "Turkestan alfalfa," regardless of its characteristics or history. The strains introduced by the department were selected from regions having low rainfall and rather extreme temperatures, where they had been grown for many seed generations. These early importations gave such promising results in the cold, dry portions of this country that a demand at once was created for seed from Turkestan. This demand resulted in the importation of miscellaneous lots of seed from all parts of Turkestan where seed could be obtained profitably, much of which came from Russian Turkestan, where it was produced under irrigation. There is, nevertheless, considerable similarity among the various commercial lots of Turkestan alfalfa.

The alfalfas that have been received from Turkestan, as compared with the commercial strains of common alfalfa grown in this country, are usually characterized by a lower and somewhat more spreading growth, smaller and slightly more hairy leaves and finer stems. But it is almost impossible even for a trained botanist to distinguish between individual plants of Turkestan alfalfa and those of the common American-grown strains, so that confusion often occurs.

Generally speaking, commercial Turkestan alfalfa has proved to be inferior to the American-grown strains in nearly every case where comparative tests have been conducted. In the eastern half of the United States, where alfalfa seed is not produced in commercial quantities, imported seed was used almost exclusively until within the past few years. This fact undoubtedly accounts for many of the failures that occurred with alfalfa in the Eastern States. In brief, the commercial Turkestan alfalfa yields less than the common American-grown strains, is shorter lived, and is less hardy than the Grimm, Cossack, and Canadian variegated. It is therefore not a desirable variety for farmers to purchase. Fortunately, commercial Turkestan alfalfa seed can be identified in most cases by the seed of Russian knapweed[3] which it almost invariably contains. The seed of this weed is not found in commercial alfalfa seed from any other source. Being considerably larger than alfalfa seed, of an oblong shape, and of an ivory, whitish color, it can usually be distinguished with little difficulty. (Fig. 2.)

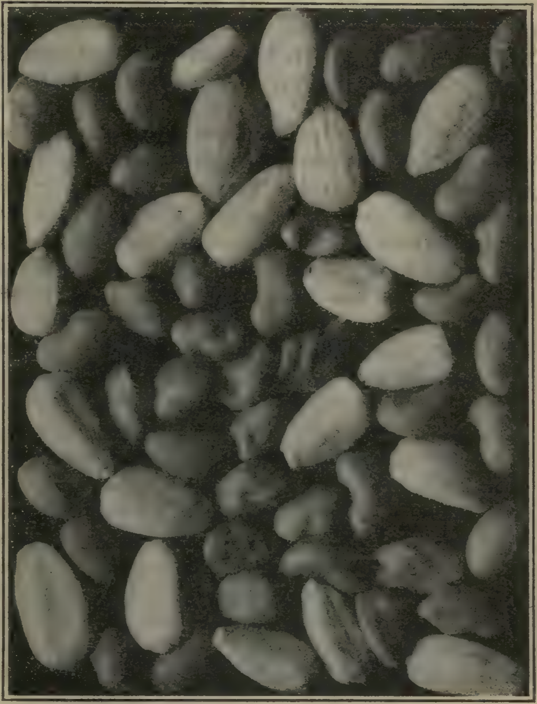

FIG. 2.—Seeds of Russian knapweed mixed with alfalfa seeds. (Magnified five diameters.) This sample shows a much larger proportion of the weed seeds (distinguished by their lighter color and their symmetrical form) than is ordinarily found in Turkestan alfalfa seed

In recent years comparatively little Turkestan seed has reached the country, though there is no reason to believe that it may not again become a factor.

VARIEGATED GROUP

Wherever the ordinary purple-flowered alfalfa and the yellow-flowered species are grown side by side a natural hybridization takes place, which results in crosses that show to a greater or less extent the characteristics of both parents. These crosses subsequently intercross among themselves and with the original parent stock, particularly the common alfalfa, thus producing numerous forms which show considerable range in flower colors. The predominant color of the flowers is the same as of the ordinary alfalfa, but brown, green, greenish yellow, and smoky hues are not uncommon, and occasionally pure-yellow flowers occur. It is because of this range in flower color that the name " variegated " has been assigned to the group.

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[3] *Centaurea picris.*

The various members of this group are so similar that it is seldom possible to distinguish between any two of them, but almost anyone can learn to distinguish a field of variegated alfalfa from one of common alfalfa with a considerable degree of certainty by observing the flower colors and the form of the seed pods. While the greater proportion of the flowers of the variegated alfalfas are the same as those of the common alfalfas, a close examination will reveal some plants having greenish or smoky flowers, and occasionally a pale or yellow one. Furthermore, the seed pods in a field of variegated alfalfa show considerable range in form. Some are circular, semicircular, or loosely coiled, but by far the greater portion of them resemble very closely the compactly coiled pods which alone occur in fields of common alfalfa. In the earlier stages of growth, however, there is no satisfactory way of distinguishing between the variegated and the common groups.

As a rule, the alfalfas that belong to the variegated group are more resistant to cold and drought than the other commonly grown varieties or strains, undoubtedly owing in a considerable degree to the presence in their ancestry of the yellow-flowered characters. This yellow-flowered species is characterized by its hardiness and drought resistance and occurs naturally over a large portion of Europe and Asia that is too cold and dry for the ordinary purple-flowered alfalfas. It is very probable that a great many lots of alfalfa that exhibit no marked tendency toward hardiness have some trace of the yellow-flowered alfalfa in their ancestry. Their lack of hardiness may be accounted for partly by the fact that the yellow-flowered species has exerted only a slight influence and partly by the fact that they were probably developed in mild climates. Variegation in the color of the flowers is not positive proof of a variety's hardiness, but it is at least a fair indication. Of the large number of strains of variegated alfalfa in question, the Grimm and Canadian variegated are the only ones that are commercially important. The Cossack has been advertised extensively and is receiving increasing attention. Baltic alfalfa and sand lucern were formerly of considerable prominence in the United States, but they are now grown to only a limited extent.

GRIMM

According to the account published by the Bureau of Plant Industry in Bulletin No. 209, Grimm alfalfa was introduced into Carver County, Minn., in 1857, by Wendelin Grimm, an immigrant from Baden, Germany. It is said that the original lot of seed, which did not exceed 15 or 20 pounds, was sown in the spring of 1858. Accounts differ as to its hardiness and the success at first attained with it. However, a sufficient number of plants survived the rather severe winters to enable Mr. Grimm to save small quantities of seed from time to time for future sowings. The first considerable quantity was apparently produced in 1867, when 480 pounds were threshed from 3 acres and sold in Minneapolis for 50 cents a pound. During subsequent years Grimm's neighbors attempted to grow alfalfa from seed produced in other parts of the United States, but in practically every case the sowings were entirely winterkilled, while at least some of the Grimm plants came through in good condition. The real value of the Grimm alfalfa was not generally recognized, however, until the attention of the Minnesota Agricultural Experiment Station was called to it, and efforts were made by that station to extend its culture. In 1905 the United States Department of Agriculture began to experiment with this variety, and since that time it has been grown in comparison with a large number of other varieties and strains, and in practically every case has proved itself equal, if not superior, to any of these in hardiness.

To the casual observer the Grimm alfalfa does not differ materially from the common strains, but a closer examination will reveal a greater diversity of forms, upright and decumbent individuals often occurring side by side. A large percentage of the flowers are of the same color as those of common alfalfa, but there are a few that are greenish, smoky, or blackish, and occasionally a plant is found with yellow flowers, indicating definitely that the strain is the result of a cross between the common and yellow-flowered species. Variegated flowers are usually more in evidence in semiarid than in humid districts.

The taproots show a tendency to branch and the crowns to be low set and spreading, characters which are undoubtedly of great importance in rendering a variety resistant to cold. In ability to produce seed Grimm alfalfa is about equal to most of the common strains.

The hardiness of Grimm alfalfa is probably due in part to the presence of the yellow-flowered alfalfa in its ancestry and in part to the process of natural selection which took place under the severe climatic conditions to which it was subjected for a long period of years in Minnesota. On account of its superior hardiness, the variety is particularly recommended for the northern part of the Great Plains region and all parts of the Northwest where little protection is afforded by the snow. It has also proved better able to survive the winters in the colder portions of the humid section of the country, where winterkilling is a serious factor. The greater cost of the Grimm seed and the inability of the variety to produce as large yields of hay in a mild climate as the common alfalfa will have a tendency to confine its culture to the more northern States, where hardiness is essential to the success of the crop.

When Grimm alfalfa first began to demand attention, all of the seed was produced in Minnesota; but, as conditions there are not especially favorable for seed production, stock was sent to Montana and other Western States in order that the available supply might be more rapidly increased. Carefully conducted tests of Grimm seed produced in Montana, Idaho, and the Dakotas indicate definitely that it has not decreased any in hardiness as a result of having been grown for one seed generation under these changed conditions. Seed is now readily available, but at a price somewhat above that asked for common alfalfa. As a result, unscrupulous dealers have offered for sale large quantities of common alfalfa under the name of Grimm. Because of this practice, prospective purchasers should take every means possible to learn whether seed is true to name.

BALTIC

There is no authentic record of the introduction of Baltic alfalfa into this country, although there is no doubt that the original stock came from Europe. The name Baltic was first applied to it in 1906, for the reason that it had been grown near Baltic, S. Dak., for about 10 years and not, as has been supposed, in the Baltic Sea region of Europe. The original seed sown at Baltic was purchased from a dealer at Hartford, S. Dak., but further than this no information regarding the history of the seed is available.

The Baltic differs slightly from the Grimm alfalfa in some minor details, but the two are so similar that it is seldom possible to distinguish one from the other, and the description as given for the Grimm variety applies equally well to the Baltic. In general, the two varieties may be considered equally valuable.

The Baltic alfalfa has unquestionably been developed in much the same way as the Grimm and therefore owes its hardiness to the same causes: The presence of the yellow-flowered alfalfa in its ancestry and the natural elimination of the less hardy plants which has taken place since its introduction into this country.

This variety is best suited for sections where the ordinary strains suffer considerable loss through winterkilling. This includes practically the same territory to which the Grimm is best adapted, and since comparative tests have shown very little difference in the hay yields of these two varieties, Baltic alfalfa has been almost entirely replaced by the Grimm variety, over which it has no special advantages. From the evidence that is now available, it is safe to conclude that seed of these alfalfas should be approximately the same price, and the farmer would not be justified in purchasing seed of one at any considerable advance over the other.

COSSACK

Cossack alfalfa was introduced into this country from Russia through the efforts of the United States Department of Agriculture in 1907. It is not as yet an important variety commercially, though receiving an increasing share of attention.

It is a comparatively early generation hybrid, and for this reason the flowers show a higher percentage of variegation than those of the older and better known strains of this group, such as the Grimm and Canadian variegated.

In the tests that have been conducted, Cossack alfalfa has compared favorably with Grimm and other variegated alfalfas but has shown no evidence of being superior for most conditions. Because of the rather limited supply, its seed ordinarily sells for appreciably more than that of the Grimm variety, but the evidence at hand indicates that the farmer is not justified in paying more for it.

CANADIAN VARIEGATED

Because of the excellent showing made in the United States by certain lots of alfalfa seed procured from Canadian sources, the United States Department of Agriculture was led to make an investigation of the fields where the seed was produced, most of which are located in lower Ontario. Upon inquiry it was learned that at least part of the original stock came from France, and it is very probable that some of it was from the sand lucern which is grown in that country as well as in other parts of Europe, since the strain as now produced has its characteristics, including variegated flowers.

The fact that it is of hybrid origin, together with the natural selection that has taken place since its introduction into Canada, is responsible for its superior hardiness.

Canadian variegated alfalfa is very similar to the Grimm variety as regards the color of its flowers and its general habit of growth. In fact, these strains are so much alike that it is seldom possible to distinguish one from the other. It also compares very favorably with the Grimm variety in yield of seed and hay, but, like it, does not yield so much as common alfalfa where the latter can be successfully grown. The Canadian variegated has proved more resistant to cold than the common variety and is therefore adapted to the same general region as the Grimm alfalfa. In the New England States and in other States having approximately the same latitude, its superior hardiness as compared with the ordinary alfalfa has been pretty well demonstrated. In tests conducted in the Northwestern States, however, it has not proved quite so hardy as the Grimm variety.

Practically all the Canadian variegated alfalfa seed imported into the United States is grown in the vicinity of Silverdale, Ontario. As the supply is rather limited, it commands a slightly higher market price than ordinary alfalfa, although generally selling for somewhat less than seed of the Grimm variety.

SAND LUCERN

It is only during the last 30 years that any attention has been given to sand lucern in the United States, even in an experimental way, although there is little doubt that small quantities of such seed had reached this country many years previously. In 1889 it was grown in experimental plats at the Delaware Agricultural Experiment Station; in 1891 at the North Carolina Agricultural Experiment Station; and near Baton Rouge, La., in 1892. The first noteworthy trial with it was made in Michigan in 1897.

Sand lucern is a hybrid alfalfa and is undoubtedly the parent of our selected strains of variegated alfalfas, such as the Grimm, Baltic, and Canadian variegated. The sand lucern described by the early botanists is quite distinct from the commercial sand lucern. The former probably represents early-generation hybrids, whereas the latter has been modified by repeated crossings with the common alfalfa.

In general appearance the commercial sand lucern is very similar to the common alfalfa. The presence of the yellow-flowered strain in its ancestry is indicated by the weaker and therefore more decumbent stems, by a certain amount of variegation in the flower colors, and by the presence of some pods with fewer and looser coils. In these respects, as well as in many others, it is similar to the Grimm variety.

The commercial sand lucern includes variegated alfalfas that have been grown under all sorts of conditions, and as a result the various lots show no consistent resistance to cold and drought. Some that have been grown for several seed generations under rather severe conditions have become, through natural selection, almost as resistant to cold or to cold and drought as the Grimm variety; others grown under more favorable conditions are no hardier than the common strains.

The hardier strains of the commercial sand lucern are to be recommended for conditions similar to those under which the Grimm variety has given satisfactory results. The less hardy strains really have no place in this country, because where they succeed the common alfalfa will grow and give larger yields. Owing to the inconsistency in the behavior of the plants grown from various lots of seed, it is doubtful whether sand lucern should be recommended for general use, particularly since we already have other well-known varieties in the Grimm and Canadian variegated which are equal, if not superior, in hardiness, yield, and seed production to the very best strains of the commercial sand lucern.

NONHARDY GROUP

There are certain alfalfas distinct from the regional strains of common alfalfa which have been developed in the southern part of this country that are especially characterized by long periods of growth, ability to make better growth under short days than the hardier northern strains, and quick recovery after cutting. These alfalfas are so much more seriously affected by low temperatures than the other commercial varieties or strains that for lack of a better group designation they have been classed as nonhardy alfalfas. Commercially only two strains, the Peruvian and the Arabian, have ever attained any degree of importance in this country. Small quantities of seed of other varieties or strains, including the Guaranda and strains from Mexico (which resemble the Peruvian), and the Elche, Algerian, and Oasis (which resemble the Arabian variety), and the India alfalfa from India, have been imported at various times but have never been grown extensively in the United States.

PERUVIAN

Of the alfalfas introduced from Peru, two distinct strains are now very generally recognized in the United States. These strains differ in several respects, but most noticeably in the abundance of hairs on the stems and leaves. It is because of this difference that such names as "smooth-leaved Peruvian" and "hairy Peruvian" as applied to these alfalfas have come into such general use.

These alfalfas were first introduced into the United States from Peru through the efforts of the Department of Agriculture in 1899, but apparently the importations that were made during that year were not perpetuated. The first introduction whose progeny is being grown commercially in this country was made in 1903. The early introductions were very hairy and proved so promising that in an effort to increase the available seed supply a larger quantity was purchased from Peru in 1908. Plants from this lot of seed proved to be less hairy, shorter, and slower in growth than those from the seed of the earlier importation. To distinguish these two strains from Peru, the local growers applied the name "hairy-leaved Peruvian" to the progeny of the introduction made in 1903 and "smooth-leaved Peruvian" to the progeny of the 1908 introduction.

In the early years of the Peruvian alfalfa industry in the Yuma Valley, Ariz., there was on the market a considerable preponderance of the so-called smooth-leaved Peruvian seed, but later investigations indicated definitely that for most parts of the Southwest the true Peruvian is superior to the smoother type. The former not only grows more rapidly, thus giving a somewhat greater tonnage of hay, but also makes more growth during the winter months, thereby furnishing a larger quantity of pasturage. As a result, there has been a gradual decrease in the acreage of the "smooth-leaved Peruvian" and a proportionate increase in the acreage of true Peruvian alfalfa. Were the true Peruvian no more than equal to the "smooth-leaved Peruvian" in point of yield, the fact that the former has characteristics by which it may be distinguished from common alfalfa, whereas the "smooth Peruvian" can be distinguished only with more or less difficulty, is sufficient ground for discouraging the use of the latter. Unscrupulous seed dealers, however, are continually emphasizing the advantages of the "smooth Peruvian" alfalfa, as this gives them an opportunity to buy mixed lots of seed at the price of common alfalfa and dispose of it as "smooth Peruvian" at a considerably advanced price without being so readily detected.

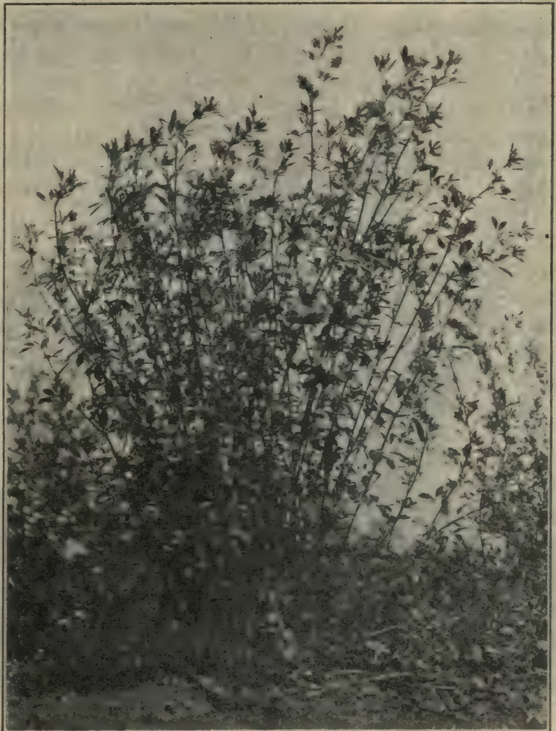

FIG. 3.—A typical plant of Peruvian alfalfa

As compared with common alfalfa, both the Peruvian and the "smooth Peruvian" are more upright, less branched, and have fewer and somewhat coarser stems. (Fig. 3.) In thick stands, however, this difference is not marked. The leaves of the Peruvian are somewhat larger than those of common alfalfa, being longer and as wide or wider. The most striking characteristic of the true Peruvian alfalfa is the pubescence or hairs on the whole plant, giving the foliage a grayish appearance.

Both the Peruvian and "smooth Peruvian" alfalfas are characterized by their rapid growth, quick recovery after cutting, and in sections having mild climates their ability to grow in cool weather and short days after the growth of ordinary alfalfa has practically ceased. Under such conditions they begin growth earlier in the spring and continue later in the fall than most other commercial varieties, thus lengthening their growing season and thereby giving more cuttings during the season. In these respects, however, the

Peruvian somewhat excels the "smooth Peruvian." In parts of the South both of these alfalfas seem to be somewhat more resistant than other varieties to certain diseases. A tendency for them to become coarse and woody when allowed to stand beyond the flowering stage may be considered a disadvantage.

Lack of hardiness will always confine the Peruvian variety to the southern and southwestern portions of the United States, where the winter temperatures are comparatively mild. It can not be grown to advantage in regions where the temperature falls below 10° F., and efforts to extend its culture into the Central and Northern States are unwarranted and sure to result disadvantageously. The variety is not drought resistant and therefore is not to be recommended for dry-farming sections.

At the present time Peruvian alfalfa in the United States is mostly grown in Arizona, California, New Mexico, and Texas. The results obtained seem to indicate that its culture can profitably be extended, not only to other portions of these States, but also to sections of other Southern States.

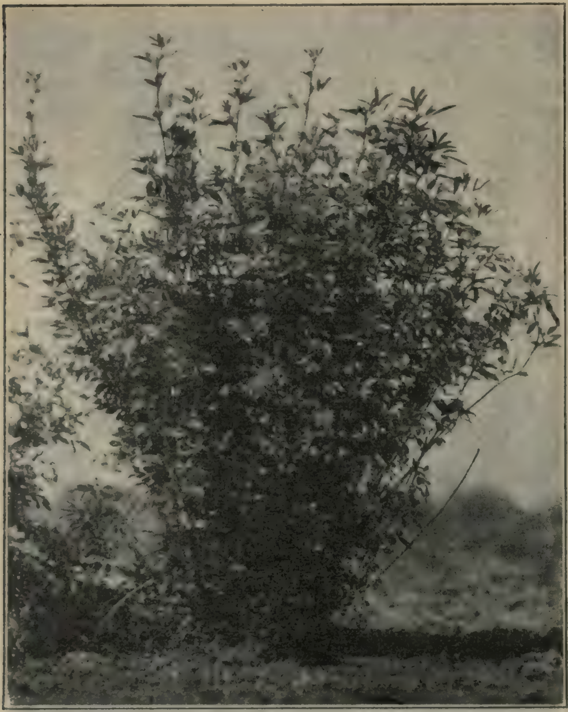

FIG. 4.—A typical plant of Arabian alfalfa

ARABIAN

The earliest recorded importation of Arabian alfalfa was made through the Office of Foreign Seed and Plant Introduction of the Bureau of Plant Industry in 1902, when two lots were received, one from Basra (Bassorah) and the other from Bagdad, Arabia. From time to time small lots of Arabian alfalfa seed have been received in this country, but in recent years the quantity of such seed imported has been almost negligible.

In general appearance the Arabian alfalfa is not markedly different from some of our common strains, but is readily distinguishable. (Fig. 4.) The plants are typically more hairy, a little shorter in growth, and somewhat more bushy than the ordinary alfalfa. However, the hairiness is not quite so pronounced as in the Peruvian alfalfa. The stems and roots are soft, the former being hollow and quite erect. The crowns spread little and set well above the ground. The leaves are generally larger, lighter colored, and broader in proportion to length than almost any other variety. The imported seed is unusually large, thus necessitating the use of a larger quantity per acre for sowing.

The Arabian variety is characterized by its quick recovery after cutting and by its ability to commence growth earlier in the spring and continue later in the fall than any other alfalfa. This makes it possible under favorable conditions to obtain one or two additional cuttings in a year, but does not result in a corresponding increase in yield.

The greatest objection to Arabian alfalfa is its tendency to be short lived. Under ordinary field conditions a good stand may be maintained for two years. The third year the plants are less vigorous and the stand decidedly thinned out. The fourth year very few plants are left. Another objection is its poor seeding habits in this country, which render the variety rather difficult to perpetuate.

Arabian alfalfa is not cold resistant and can be grown successfully only in sections having comparatively mild winters, such as occur in our Southern and Southwestern States. It is not injured by high temperatures when there is an abundance of moisture in the soil. Because of its inability to resist drought, this variety is not suitable for dry-farming sections.

At the present time there is very little Arabian alfalfa in the United States, and results obtained in most cases indicate pretty clearly that this variety, all things considered, is not equal to either the Peruvian or ordinary alfalfa for general use, even in those parts of this country to which it is best adapted.

YELLOW-FLOWERED GROUP

In a fifth group are included the various forms of the yellow-flowered species,[4] sometimes referred to as "Siberian alfalfas." This term, however, is misleading, since not all of the yellow-flowered alfalfas come from Siberia. These alfalfas are of comparatively little agronomic importance at the present time, but they have been so extensively exploited that it is deemed advisable to discuss them along with the important commercial varieties of alfalfa.

The first importation of any of the forms of yellow-flowered alfalfa of which there is a record was made by the Department of Agriculture in 1898. Accidental introductions, however, occurred before that date. Since 1898 numerous lots of seed have been procured from various parts of Europe and Asia. The plants from these importations vary greatly in their characteristics, including habit of growth. Most of them are procumbent (fig. 5); a few are nearly as erect (fig. 6) as the ordinary purple-flowered alfalfas. Few of the forms possess true taproots, but have a much-branched root system. In general, the crowns are produced somewhat below the surface of the ground, a protective adaptation which enables the plant to endure cold and drought. The flowers are yellow, and the seed pods are crescent or sickle shaped.

The Department of Agriculture has thoroughly tested many forms of the yellow-flowered alfalfa in various parts of the country. The results of these tests lead to the conclusion that their chief value is for hybridizing with the purple-flowered alfalfas in order to produce hardy and drought-resistant strains. It is believed that of themselves they are not sufficiently productive to be profitable under cultivation, since they rarely give more than one cutting in a season. Furthermore, most of the forms are not sufficiently erect to be harvested for hay by field machinery, and almost without exception they produce seed very scantily. A few of the best forms of the yellow-flowered alfalfa give one cutting of hay that frequently outyields the first crop of the ordinary commercial varieties. However, the higher yield in this one crop seldom offsets the inability to produce more than one cutting in a year.

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[4] *Medicago falcata.*

For use on uncultivated pasture and range lands, the tests so far indicate that these alfalfas are not sufficiently aggressive to be of much value. In fact, it is very doubtful whether even a scattering stand of plants would survive on the average dry range, even if careful attention were given to seeding.

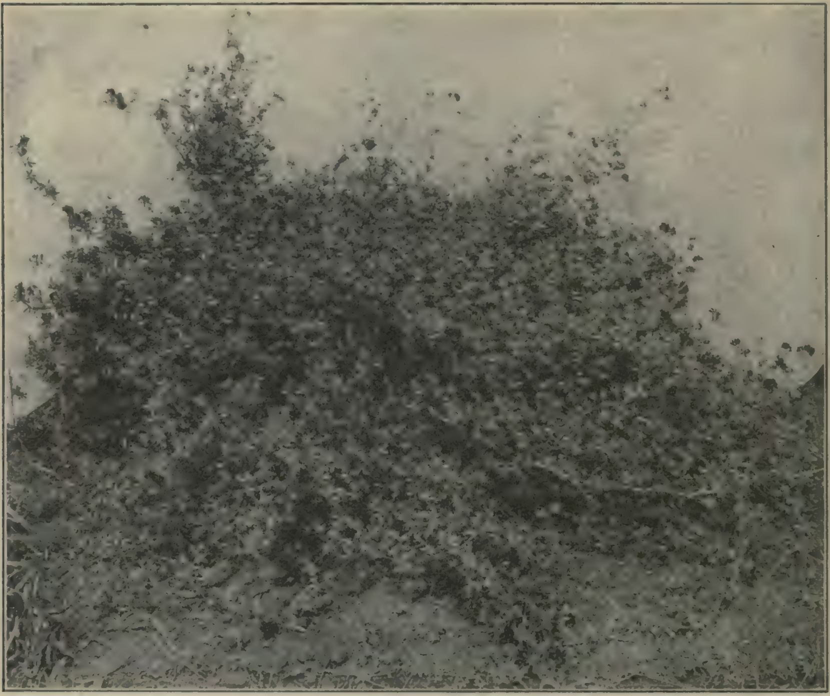

FIG. 5.—Yellow-flowered alfalfa (*Medicago falcata*), decumbent type

The Department of Agriculture advises farmers to go to no great trouble or expense in testing these yellow-flowered alfalfas at the present time, as there is still much work for plant breeders to do.

There are two forms or, rather, two importations that have received considerable attention by reason of being extensively advertised in agricultural journals. They are known as the Semipalatinsk and Orenberg, receiving their names from the Provinces in Siberia and Russia from which they were imported. These lots are superior in some respects to many other forms of the yellow-flowered alfalfas, but they are composed of mixed strains and are subject to the same objections that apply to the group as a whole.

VARIETIES FOR VARIOUS SECTIONS

In recent years numerous tests have been conducted in all parts of the United States with alfalfas from various sources. These tests have had as their main object the determination of the variety or strain that can be most profitably grown in a specific locality or under certain conditions. As a result of extensive tests it is now possible to designate with considerable definiteness the part of the country where each of the various commercial strains or varieties may be expected to give the most satisfactory results. (Fig. 7.) There are, however, more or less extensive areas in all parts of the United States where the conditions are so unfavorable to alfalfa that an attempt to produce any of the known varieties or strains is almost certain to result in their failure to grow or in their inability to give profitable yields.

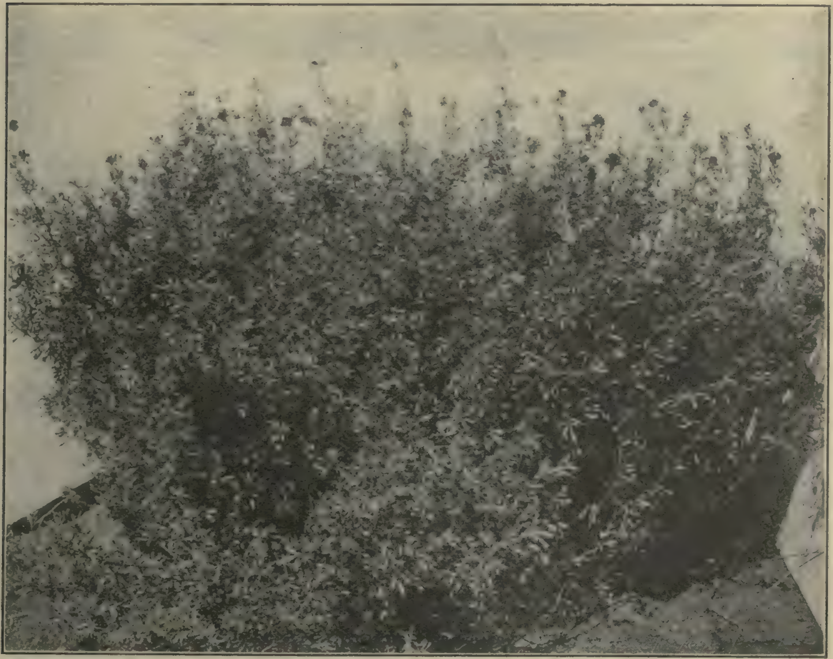

FIG. 6.—Yellow-flowered alfalfa (*Medicago falcata*), one of the more erect forms

In choosing a variety or strain it is well to bear in mind that the quick-growing alfalfas, because of their tendency to produce heavier yields, should be used as far north as they will survive the winters. The variegated alfalfas, including the Grimm, Baltic, Cossack, and Canadian variegated, have usually proved more resistant to severe winter conditions than the ordinary strains and therefore give the most satisfactory results where winterkilling is a serious factor. They are not to be recommended generally, however, for conditions where ordinary alfalfas will succeed, owing to the higher cost of the seed and to the fact that they have a tendency to yield less than the latter under such conditions. As a rule, they may be expected to give the best results in the following States and localities: New

England States, New York, Michigan, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Montana; northern Nebraska, Illinois, Indiana, Ohio, and New Jersey; the greater part of Pennsylvania and Wyoming; and the western half of Colorado. There are, however, areas in several or all the States mentioned where the soil or climatic conditions are exceptionally favorable to the growth of alfalfa and where the common alfalfa will give more profitable returns. Such areas occur on the limestone soils of New York, Michigan, Wisconsin, and Ohio, as well as parts of Massachusetts, Rhode Island, Connecticut, and Long Island where the climate is modified by proximity to the ocean, thus reducing the losses from winterkilling. If difficulty is experienced in obtaining seed of the Grimm or other hardy variegated varieties for the northern part of the United States, it is recommended that seed of some good northern regional strain be procured. For such conditions these strains generally have proved to be superior to those from farther south.

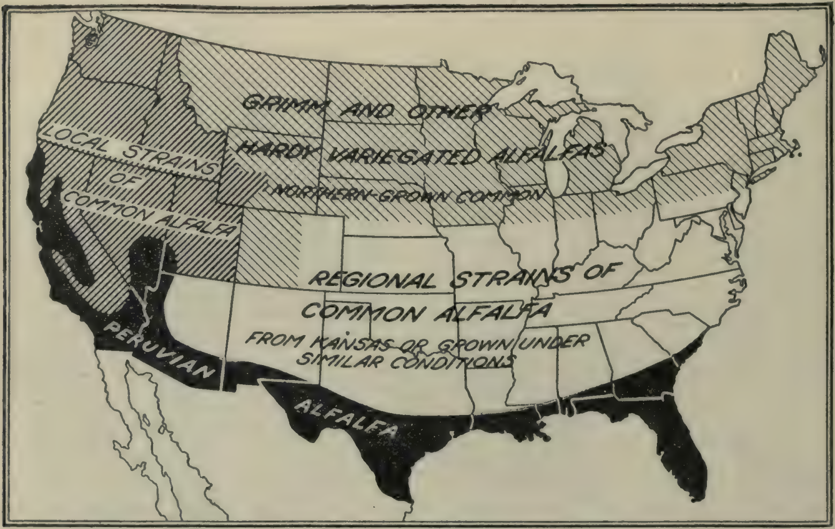

FIG. 7.—Outline map of the United States, showing the varieties or strains of alfalfa that are recommended for various sections, based upon climatic conditions

In sections having very mild winters, Peruvian alfalfa has proved more profitable than any other commercial variety or strain, owing to its ability to produce considerably heavier yields. Usually it can be grown to advantage only in sections where the minimum temperature is not lower than 10° F. and where ordinary alfalfa will succeed. The section to which this alfalfa is adapted includes the greater part of California, except the mountainous portions; southern Arizona; southern New Mexico; southern Texas; and a strip of country bordering on the Gulf of Mexico and extending northward along the Atlantic Ocean, finally ending in the vicinity of Charleston, S. C. In all the great belt of country lying between the area on the south where Peruvian alfalfa has proved most profitable and the line on the north marking the southern limit of serious winterkilling and extending westward from the Atlantic Ocean to the Rocky Mountains, the common strains that have been developed in Kansas, Oklahoma, Texas, and under similar conditions have given the most satisfactory results. They are somewhat more satisfactory for this area than the common strains from the intermountain region.

In the intermountain region, which embraces practically all the United States not included in the three preceding regions, seed from locally developed strains generally gives as satisfactory results as that from other sections of the country, although here, too, in some of the valleys having high altitudes Grimm alfalfa is preferred. The States or parts of States falling in this group are Idaho, Nevada, Utah, southwestern Wyoming, the mountainous portions of California, and the greater part of Oregon and Washington.

PURCHASING SEED

Before buying alfalfa seed there are three points upon which the purchaser should have information: The name of the variety, the section of the country in which it was produced, and the quality of the seed with regard to both germination and purity. Unfortunately, it is not possible to distinguish between varieties or strains of alfalfa by the appearance of the seed, and the tests that so far have been developed to assist in this connection are not of much practical value to the farmer. Except in the case of imported Russian Turkestan seed, there is no easy means of telling from the appearance of a sample of seed where it was grown. It is important, therefore, that dealings be had only with thoroughly reliable and intelligent seedsmen and growers.

The viability of the seed, or its ability to germinate, is clearly indicated in its appearance. Plump seed of a bright olive-green color almost invariably germinates well, while shriveled seed or seed that is of a brownish color usually germinates poorly. With age alfalfa seed turns a reddish brown color. Some viable seed may possess this color, but such seed should not be purchased without a germination test, even if it is offered at a price materially less than that asked for seed of a fresh olive-green color. When a germination test is desired it can be made by placing 100 seeds between cloths or blotting paper and keeping them moist and at a temperature of about 70° F. After five or six days most of the readily viable seeds will have sprouted. There will be some, however, that will remain hard, especially if they are of the variegated varieties. Many of these hard seeds will grow when put in the ground, and therefore they should be considered in estimating the percentage of germination. The Department of Agriculture, through its main seed laboratory and branch laboratories, is prepared to make a limited number of germination tests free of charge; but, in order to prevent delay beyond the seeding time, samples should be mailed to the department at least two months in advance.

With regard to the purity of alfalfa seed, every farmer should be able to recognize readily the most important weed seeds and other impurities that are commonly found in it. Seed to be acceptable should contain not more than 2 per cent of impurities. At the present time there is almost no attempt to adulterate alfalfa seed in this country, but every lot should be very carefully examined for seed of noxious weeds, especially dodder, before it is purchased. The seeds of dodder are smaller than those of alfalfa, more nearly round, and have a pitted surface which can be detected only by the aid of a lens. As dodder is a troublesome weed and its seed can not readily be separated from that of alfalfa, dodder-free seed should be demanded by the purchaser. Seeds of buckhorn should always be looked for when samples of alfalfa seed are examined before purchasing. These seeds are shiny brown in appearance, boat shaped, and about twice the length of the alfalfa seed. Seed of Russian knapweed, which has previously been described, should also be searched for carefully, as its presence indicates the imported Turkestan variety. (See fig. 2.) Although the Seed Laboratory of the Department of Agriculture is prepared to make a purity analysis of a limited number of samples free of charge for private individuals, it is very desirable that every farmer acquaint himself with the impurities and noxious weed seeds that alfalfa seed commonly contains, in order that there may be no serious delay in purchasing seed for sowing.

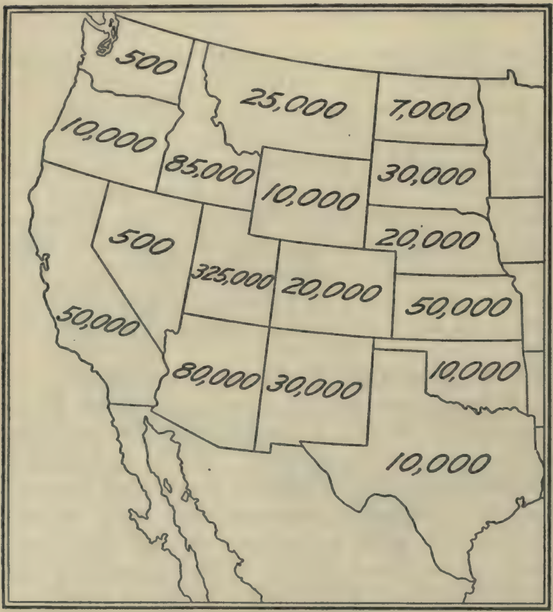

FIG. 8.—Map showing the estimated production (in bushels) of alfalfa seed in 1924 in the States lying west of the ninety-fifth meridian, based on information obtained by the seed-reporting service of the Bureau of Agricultural Economics, United States Department of Agriculture

SEED PRODUCTION

In keeping with the demand resulting from the gradual increase in alfalfa acreage, there has been a yearly increase in the production of alfalfa seed. The census of 1909 places the seed production at approximately 16,000,000 pounds. According to the best estimates of the seed-reporting service of the United States Department of Agriculture this had increased to 25,000,000 pounds in 1921, 30,000,000 in 1922, 33,000,000 in 1923, and 45,000,000 in 1924. The commercial production of alfalfa seed in this country is confined largely to that region lying west of the ninety-fifth meridian where irrigation and dry-land farming are practiced. The estimated number of bushels of seed produced in 1924 by each State lying west of this line is shown on the accompanying map (fig. 8). Most of the seed of the Grimm variety is produced in Idaho, Montana, North Dakota, South Dakota, and Nebraska. The Peruvian seed industry is confined almost entirely to those portions of California and Arizona known as the Yuma Valley. Only a small quantity of seed is grown east of the ninety-fifth meridian, as alfalfas do not produce seed satisfactorily under humid conditions. For this reason it is seldom profitable to attempt to grow seed in the Eastern States. It is true that there are limited areas in these States where comparatively small quantities of alfalfa seed are produced, but they are exceptions. Ordinarily it is very much more profitable for the eastern farmer to purchase seed that is produced in the West than to attempt to grow it.

POSSIBILITIES IN BREEDING

There are possibilities in the breeding of alfalfa for the production of strains that will be more resistant to cold and drought or better adapted to special conditions than those that are at present in general use. However, to establish a new strain of alfalfa involves such a long period of time and so much labor and expense that farmers can hardly afford to undertake work of this kind. The breeding of alfalfa, which includes both selection and hybridization, is properly the work of the United States Department of Agriculture and the various State agricultural experiment stations, since these institutions are much better equipped for such work than private individuals. In this country most of the alfalfa breeding is, and doubtless always will be, confined largely to sections west of the Mississippi River, where the conditions are more favorable for the production of alfalfa seed.

PUBLICATIONS RELATING TO ALFALFA

[These may be ordered by their numbers]

The following Farmers' Bulletins relating to alfalfa will be sent free of charge upon application to the Department of Agriculture, Washington, D. C.:

636. The Chalcis-Fly in Alfalfa Seed.
677. Growing Hay in the South for Market.
865. Irrigation of Alfalfa.
943. Haymaking.
944. Controlling the Garden Webworm in Alfalfa Fields.
977. Hay Caps.
982. Control of the Green Clover Worm in Alfalfa Fields.
987. Labor-Saving Practices in Haymaking.
1094. The Alfalfa Caterpillar.
1185. Spraying for the Alfalfa Weevil.
1229. Utilization of Alfalfa.
1232. Seed-Marketing Hints for the Farmer.
1250. Green Manuring.
1265. Business Methods of Marketing Hay.
1283. How to Grow Alfalfa.

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February 5, 1926

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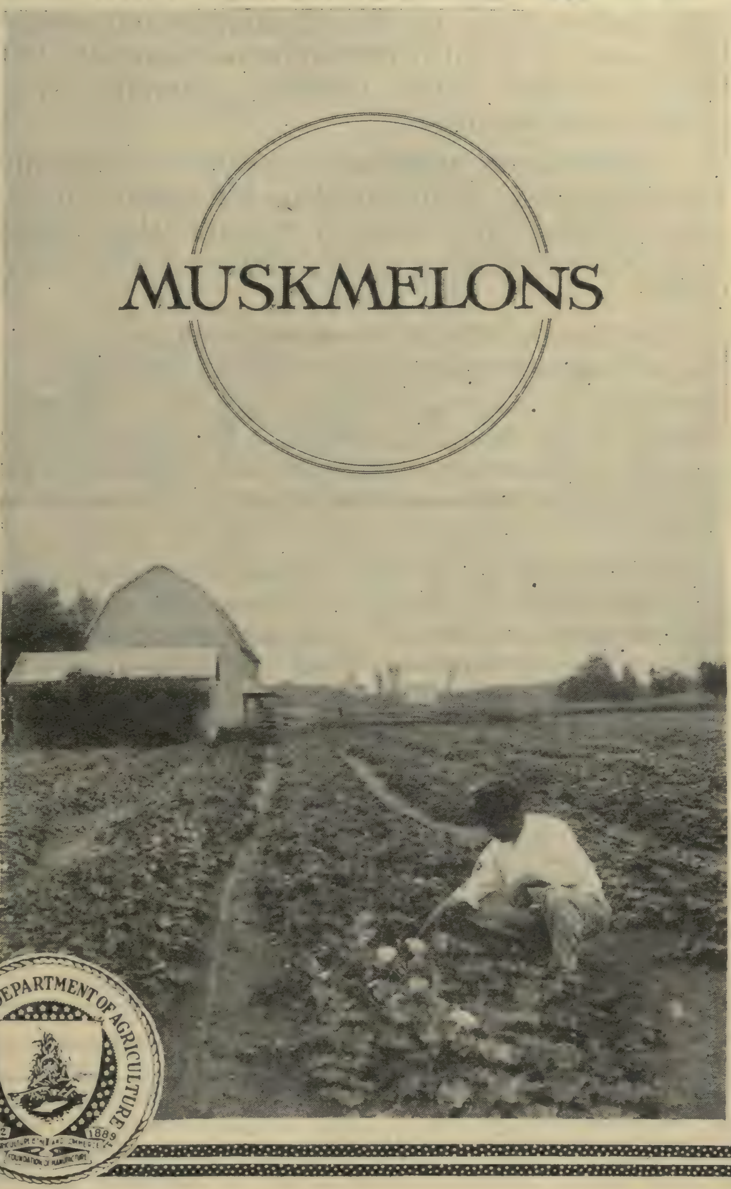
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1468

Rev Jul 1940

MUSKMELONS



MUSKMELONS, usually referred to as "cantaloupes" by the trade, are grown commercially and for home use over a wide range of territory in the United States, but the big commercial producing areas are located in California, Colorado, Arizona, Georgia, North Carolina, Maryland, New Jersey, and Arkansas.

Approximately 82,000 acres are devoted annually to the growing of muskmelons for market in the United States, and the yield of marketable melons equals the capacity of about 32,000 standard freight cars.

The essentials for the production of good melons are a relatively long growing season, with plenty of moisture during the growing period and bright sunshine at the time of maturity. The crop can be grown on almost any well-drained fertile soil, but does best on rich sandy loam and on light alluvial soils.

Muskmelons attain their highest flavor and quality only when produced on disease-free vines and where they are allowed to become practically ripe before being removed from the vines. Melons picked at the stage termed "one-half slip" can be shipped across the country under refrigeration and still allow time for prompt marketing.

The production of muskmelons for carload shipment is now a highly specialized industry. There is a splendid opportunity for the local growing of high-quality melons for sale on special markets and at roadside markets.

Washington, D. C. Issued April, 1926

MUSKMELONS

By W. R. Beattie, *Horticulturist, Office of Horticultural Investigations, Bureau of Plant Industry*

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IMPORTANCE OF THE MUSKMELON INDUSTRY

MUSKMELONS, usually referred to as "cantaloupes" by the trade, are shipped in car lots from 23 States, and some 10 additional States are producing the crop in considerable quantities for the market. According to the Division of Crop and Livestock Estimates, Bureau of Agricultural Economics, United States Department of Agriculture, the acreage planted to muskmelons for commercial purposes in the United States during the five-year period from 1919 to 1923 was 72,950 in 1919, 74,530 in 1920, 77,840 in 1921, 103,040 in 1922, and 82,040 in 1923, the average being 82,080 acres. Yields during this period have averaged 136 standard crates per acre, or a total average yearly production of approximately 11,000,000 crates. The crop produced in 1923 is given at 11,197,000 standard crates, which equals the capacity of about 32,000 standard freight cars. California led in the shipment, with 6,102,000 crates; Colorado came second, with 1,078,000 crates.

The above figures show that during the five-year period ended with the season of 1923 the area planted to muskmelons for commercial purposes in the United States has increased from a little less than 73,000 to a little more than 82,000 acres. The yield per acre, however, has been slightly reduced, with the result that the increase in production has not been in proportion to the increase in acreage. Under present conditions the car-lot markets for muskmelons are well supplied, and the demand is for improvement in the market quality and grade of the product. There is, however, a good demand for locally grown melons for sale at roadside markets and for supplying the smaller towns that do not receive carload shipment. The most urgent need in the large commercial melon-producing areas, is for standardization of production and better methods of handling.

The muskmelon industry is at present fairly well distributed over the entire United States and parts of Canada, but the large shipping sections of the West are in California, Colorado, and Arizona, and the more eastern ones in Arkansas, Maryland, New Jersey, Indiana, Delaware, Michigan, North Carolina, and Texas. In nearly every section of the country suitable natural conditions for growing muskmelons are found in local areas, within which success is dependent mainly upon the skill and knowledge of the grower. The muskmelon industry of the United States has been seriously injured by the marketing of great quantities of melons that have been picked before reaching the proper stage of maturity. Melons that are properly matured and carefully handled give satisfaction, but immature stock reaches the markets with poor flavor and low quality and is a disappointment to the consumer.

Good seed of a desirable market variety, the judicious use of fertilizers, insect and disease control, and clean culture are essential to the production of high-grade muskmelons, but the proper maturity and handling of the product are of major importance.

CLIMATE

Muskmelons require a fairly long growing season, with plenty of heat and sunshine, a dry atmosphere, and sufficient soil moisture. As a rule 120 to 140 days of good growing weather are necessary for the production of muskmelons, but good crops are frequently grown in 90 to 100 days under especially favorable weather and soil conditions. The natural home of the muskmelon is in the hot valley regions of southern Asia, and the more important commercial producing sections of this country are located in regions having a similar climate. In addition to high temperature, the muskmelon requires an abundance of soil moisture from the time the plants start until the beginning of the ripening period. Bright sunshine with high temperature and dry atmospheric conditions during the ripening period are essential to the production of the best flavored melons. Where the water is supplied by irrigation, moisture conditions are practically under the grower's control; but in sections of natural rainfall continued showery weather during the growing period is conducive to the development of leaf diseases, which, however, may usually be controlled by spraying or dusting. Excessive irrigation or rainfall during the ripening period or immediately preceding it will cause the melons to be lacking in flavor and carrying qualities.

The climatic conditions in the Imperial Valley, in the Rocky Ford section of Colorado, and in many parts of the Eastern and Southern States may be included among the most desirable for muskmelon growing. The fact that muskmelons are produced for the market in carload lots in 23 States and in smaller quantities in at least 10 additional States indicates the range of climatic conditions under which the crop can be successfully grown.

SOIL

The soil requirements of the muskmelon are less important than those of climate. The crop does best on well-drained warm sandy loam or silt-loam soils, but some of the finest melons are grown on sandy river-bottom lands and on rich clay loams. The large commercial crop produced in the Imperial Valley of California is grown mainly on what is known as the Holtville silty clay loam; that of Indiana, Illinois, and other of the North-Central States for the most part grows on light clay loams. The commercial crop of Colorado, Arkansas, Texas, Michigan, New Jersey, South Carolina, and southern Georgia is produced largely on sandy loams. Warmth, good drainage, and an abundance of rapidly available plant food with plenty of humus to retain natural moisture are the essential requirements of a soil on which to grow muskmelons. They will not endure an overflow, and soils on which water will stand in the furrows after a rain or that wash badly are not suited for the crop. Muskmelons for home use may be grown on any good garden soil, provided the season is of sufficient length and other climatic conditions are right.

ROTATION

Crop rotation has proved one of the most effective means for reducing disease infestation and maintaining proper plant-food and physical conditions of the soil. A rotation in which the melon or some other related vine crop is not planted on the land oftener than once in five or six years is recommended. The crops employed in the rotation will depend upon the locality, but they should not include cucumbers or any of the vine crops that are subject to the same diseases as the muskmelon. In sections where root-knot is prevalent special care must be taken, as cucumbers, tomatoes, and several other crops aid in carrying over the infestation in the soil. Land that has been in alfalfa or clover or in pasture for a period of years is most likely to be free from muskmelon-disease organisms.

Muskmelons should not, as a rule, follow corn or any crop that draws heavily upon the nitrogenous plant food in the soil. In the western sections the best yields are obtained on old alfalfa land. Where alfalfa land is not available, annual cover crops, especially the legumes, are used as a substitute. In the eastern sections the best results are obtained on clover or alfalfa sod or on land that has been enriched by turning under annual legumes grown as cover crops. In the market-garden districts where alfalfa and clover are not extensively grown it is customary to plant muskmelons on land which has previously been in potatoes or sweet potatoes followed by a cover crop.

VARIETIES

Muskmelons grown for carload shipment consist mainly of the smaller, nearly round, heavily netted sorts of both the green and salmon fleshed varieties. This type has been selected (1) for its carrying qualities, due to its having a heavy protective netting and a firm flesh; (2) on account of its uniform size and shape, which adapt it to grading and packing; and (3) for its superior quality when properly ripened on the vine, making it suitable for the hotel and restaurant trade. A secondary group of shipping melons includes the Casaba, Honeydew, and other of the semikeeping or winter muskmelons. In addition, there are a number of varieties suitable for shipping but which are grown mainly for home use and local marketing.

Special strains or subvarieties of muskmelons are produced by cross-pollination, either accidental or by artificial means, but through lack of permanence of certain characters these strains change rapidly and are soon replaced by newer sorts that appear more promising. Wherever a variety has become especially popular it has been divided along the lines of slight differences into many subvarieties or strains. Often these differences are so poorly established that they lose their distinctive characters in a few years when handled in a large way.

No attempt is made in this bulletin to give an extensive or detailed classification of the varieties of muskmelons but rather to group and briefly describe those that are at present most important from commercial and home-garden standpoints. The degree of quality referred to in the description of the different varieties is found only in fruit that has ripened on healthy vines retaining their leaves in good condition until after the melons have matured. Heavy netting is not necessarily an indication of good table quality but apparently denotes good shipping traits. Many of the varieties best adapted for home use or local marketing lack carrying qualities and are not suitable for long-distance shipment.

The varieties of muskmelons are divided in this bulletin for convenience into two main classes as follows: Class 1, netted melons, including those varieties that constitute the greater part of car-lot shipments and those ordinarily grown for home use and for local markets; class 2, melons of the Casaba type, which may be marketed during the late summer or stored for winter use. The brief descriptions that follow are intended as an aid to growers in selecting the type and variety of muskmelon adapted to their particular locality and purpose.

CLASS 1.—NETTED MUSKMELONS

A.—SHIPPING VARIETIES

(1) **Defender group.**—These varieties originated in Michigan. The individual melons are about the size of the Netted Gem, but taper toward each end more sharply than specimens of that variety. Melons of the Defender group, especially the earlier varieties, are moderately ribbed, with more or less netting on the ribs, but with bare sutures (stripes between the ribs). The rind is green; flesh deep salmon, thick, with small cavity, texture firm and fine, aroma high and musky; flavor sweet and distinct. Six strains or varieties are here described.

Defender.—Fruits medium size, oval, slightly ribbed, covered with gray netting. Flesh firm, fine grained, and of high flavor, retaining its rich, deep orange-yellow color and quality to the outer shell. This variety was selected for its thin rind and small seed cavity. (Fig. 1.)

Paul Rose (*Petoskey*).—Fruits medium size, oval, slightly ribbed, densely netted. The flesh when ripe is orange-yellow, thick, firm, sweet, and highly flavored. One of the earliest varieties of this group.

Admiral Togo.—Fruits small, oval, rather heavy netting; flesh thick, orange color, of good quality; has good shipping qualities; suitable for the home garden and local marketing. (Fig. 2.)

Burrell Gem.—Fruits medium size, oval in shape, 4 to 5 inches in diameter and about 6 inches long, tapering at ends; has well-defined ribs with a clearly marked suture; ribs heavily netted; flesh thick, rich salmon color, fine grained, and of spicy flavor; seed cavity small, giving the melon good shipping qualities. One of the important varieties grown in the Rocky Ford (Colo.) district. (Fig. 3.)

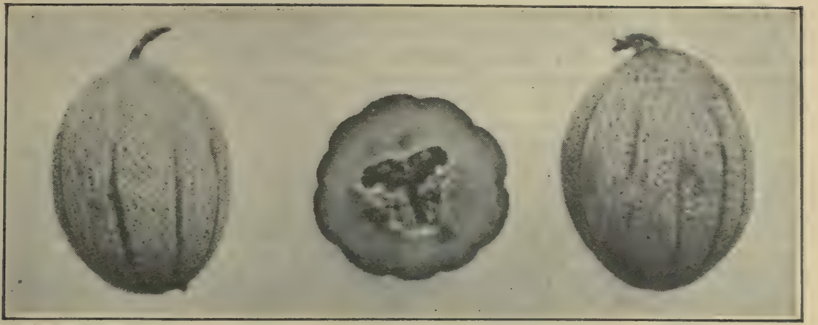

FIG. 1.—Defender muskmelons

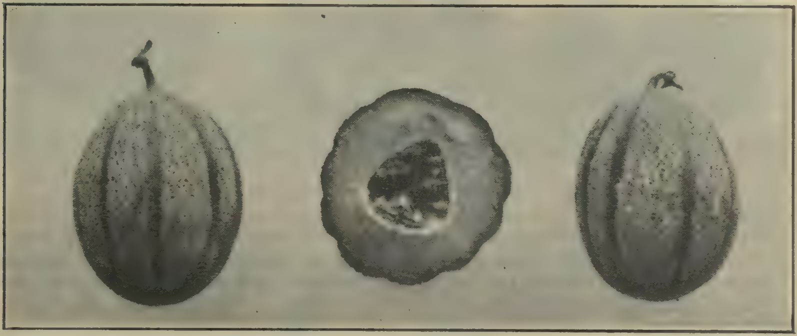

FIG. 2.—Admiral Togo muskmelons

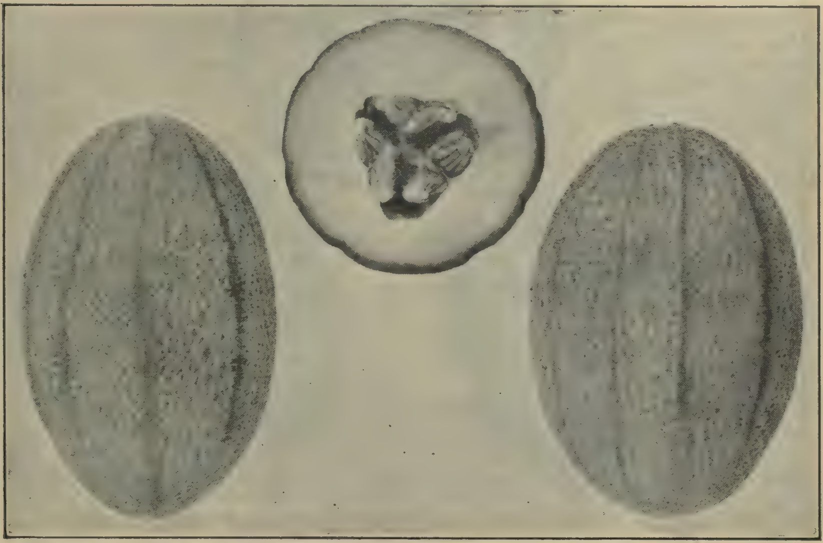

FIG. 3.—Burrell Gem muskmelons grown in Colorado

Hoodoo.—Nearly round in shape and more completely netted than Defender; flesh deep orange and of good flavor. (Fig. 4.)

Hearts of Gold (*Improved Hoodoo*).—Fruits round to slightly oval and almost ideal in size, shape, and netting for shipping. Slightly ribbed with sutures; flesh thick, rich orange in color, fine grained, and of excellent flavor; seed cavity small and triangular in shape. One of the characteristics of the variety is that the fruits do not yellow in ripening but retain their natural green color, remaining firm for a considerable period after gathering. A late introduction and one of the most popular commercial and home-garden varieties. (Fig. 5.)

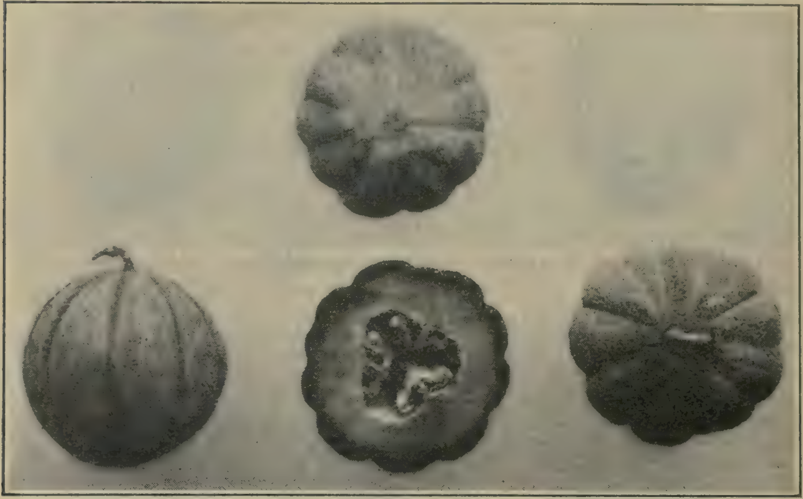

FIG. 4.—Hoodoo muskmelons

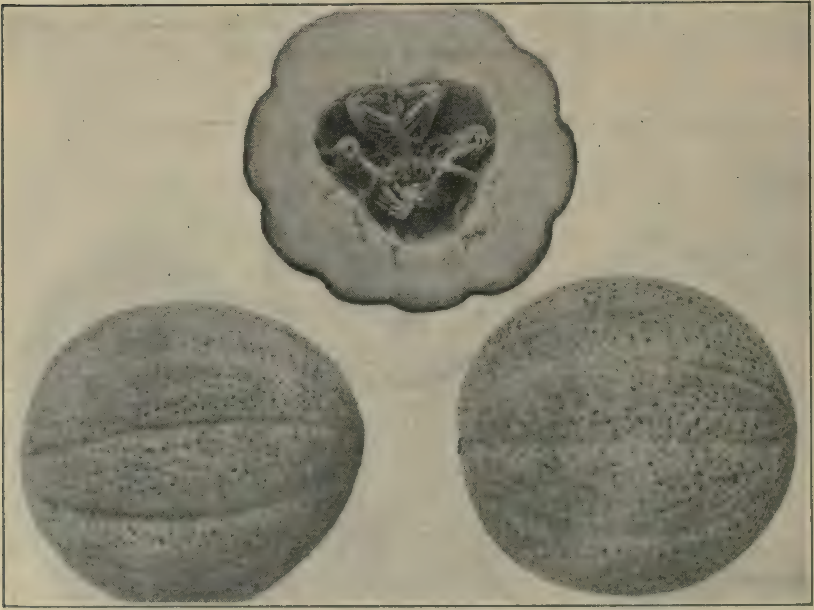

FIG. 5.—Hearts of Gold (*Improved Hoodoo*) muskmelons

(2) **Netted Gem group.**—Varieties of the Netted Gem series have been developed for the most part at Rocky Ford, Colo., and selected primarily for shipping qualities. The original oblong Netted Gem, with decided ribbing and bare sutures, has been changed into a globular melon, almost without ribs and solidly netted. This style of melon packs and carries better than the parent variety. Some of the selections or strains are described as follows:

Rocky Ford.—Not a distinct variety but a name given to melons of the Netted Gem type as developed in the Rocky Ford district. (See fig. 12.)

Pollock 25.—A selection made to meet the requirements of the Colorado muskmelon growers for a long-distance shipping melon of good quality and resistant to anthracnose or rust. Medium size, round or slightly oval in shape, little or no ribbing, heavily netted; flesh medium thick, a rich salmon-pink color on the inside, shading to a deep green near the rind; fine grained, very solid, highly flavored: seed cavity small; vines not entirely rust resistant in sections having natural or excessive rainfall.

Pollock 10–25.—A selection from Pollock 25, to which it is similar except that the flesh is of a deeper salmon color on the inside, shading to green near the rind. Extensively grown in the commercial muskmelon districts of California.

Eden Gem.—Fruits medium size and of uniform shape, solidly netted: flesh thick, firm, and fine grained; color varying to light golden; of excellent flavor and reasonably resistant to rust. A good long-distance shipper.

Edwards Perfecto.—There are two types of this variety, one with flesh of salmon tint, a large oblong melon finely netted, and one with pink or red flesh, nearly round and completely covered with netting. One of the best shipping melons.

Abbott Pearl (*Pearl Pink, Buckskin*).—The fruit averages larger than Pollock 25. In shape it is almost round, slightly oval, but irregular in size. The exterior is whitish green, without ribs, and completely covered with coarse netting; flesh deep-salmon color to the rind, fine grained and firm, with good flavor; seed cavity small, making it a good shipper. This variety should not be picked from the vine until it will slip.

Honey Ball (*Texas Honey Ball*).—Probably a cross between Texas Cannon Ball and Honey Dew. Fruits slightly larger than Netted Gem; round, slightly netted, greenish white until ripe, then turning to a light yellow; flesh thick, green color, sweet, and of delicious flavor; seed cavity small; melon firm and said to be a good shipper. Very prolific.

B.—HOME AND MARKET GARDEN VARIETIES

(1) **Tiptop group.**—This group includes some of the most important of the salmon-fleshed varieties of muskmelons, especially for home use and near-by marketing. Fruits large, sometimes 10 inches or more in diameter and weighing from 5 to 12 pounds. The fruits are globular or slightly oval in shape, have rather prominent ribs and usually scant netting. The outside color is greenish gray, becoming a light yellow when ripe. Flesh salmon in color, deep, of medium texture, high aroma, and fair to excellent quality. The following are among the most important varieties that compose this group:

Tiptop.—This variety is extensively grown in the North-Central States, especially east of the Mississippi River. Fruits medium size to large, weighing 5 to 8 pounds, slightly oval, ribbed, and well covered with light netting; flesh fairly thick, salmon to deep yellow in color, cavity rather large; an excellent melon for home use and local marketing. (Fig. 6.)

Surprise.—About the size of Tiptop and similar to it but more nearly globular.

Bender (*Bender Surprise*).—A selection from Surprise, to which it is very similar.

Baker.—A selection from Surprise, but having a heavier netting and said to be a better shipper.

Indiana.—Very similar to Tiptop.

Ohio Sugar.—Resembles Tiptop in size and general appearance, but has a light-green flesh with a slight pineapple flavor. (Fig. 7.)

Milwaukee Market.—Fruit deep fleshed, very uniform, large, and with shallow ribs. (Fig. 8.)

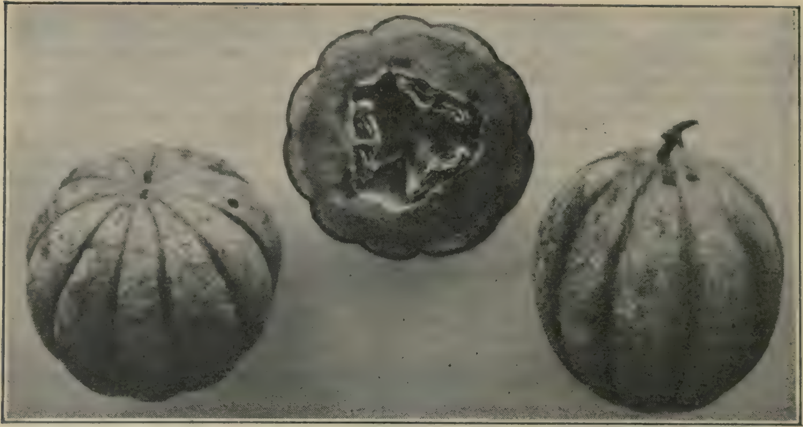

Fig. 6.—Tiptop muskmelons

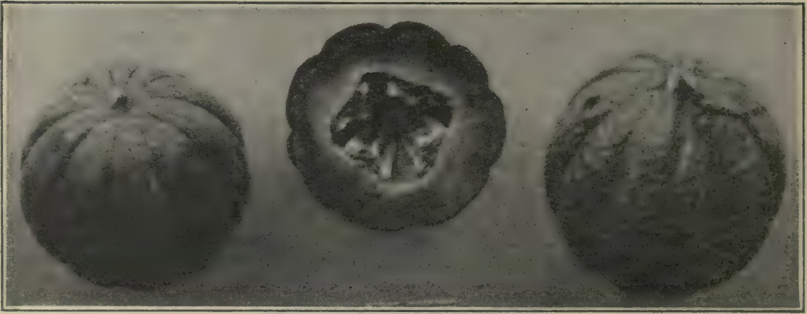

Fig. 7.—Ohio Sugar muskmelons

Irondequoit.—Fruit very large, well netted, weighing up to 10 and 12 pounds; suitable only for home use and special local marketing.

(2) Hackensack (*Extra Early Hackensack; Turk's Cap*).—One of the best-known older varieties. Fruits large, globular, sometimes slightly flattened, prominently ribbed, ribs of irregular width, covered with coarse netting; exterior color green, turning to slight yellow or decidedly yellow when ripened; flesh green, not very deep, medium to coarse, juicy and sweet. Grown only for special local markets.

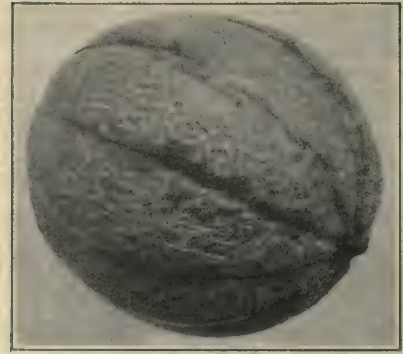

Fig. 8.—Milwaukee Market muskmelon

(3) Miller Cream (*Osage*).—Fruits very large, globular or slightly oblong, usually 6 to 7 inches long, very solid, and weighing 5 and 6 pounds. Outside color green, ribs shallow, little netting. Flesh deep-salmon color, thick, good texture, high aroma and fine flavor; cavity small. The vines are vigorous and productive. An excellent variety for growing as a main crop in the eastern section. (Fig. 9.)

(4) Jenny Lind.—Grown for many years in New Jersey for the markets of Philadelphia and the New Jersey coast. A small flat melon, about 4 to 4½ inches broad, flattened at the ends. and weighing 1½ to 2 pounds; ribs prominent, coarsely netted; blossom end of

fruit having a scar or warty appearance; cavity large; flesh thin, rather coarse grained, but with a pronounced aroma and very sweet flavor. (Fig. 10.)

(5) **Fordhook.**—A recent introduction. Fruits small, about 3½ inches long by 4½ inches broad and weighing 1½ to 2 pounds, flattened at the ends, with low ribs and fairly heavy netting; flesh moderately thick, good texture, salmon color, and with a good aroma and flavor. Aside from the color of the flesh it resembles Jenny Lind closely. (Fig. 11.)

(6) **Emerald Gem.**—Fruits of medium size, usually 5 to 6 inches in diameter and weighing 2 to 3 pounds; globular in shape; ribbing irregular and with little netting; color green; flesh very deep, of fine texture, deep-salmon color, with a high aroma and good quality; very popular for home use and special local markets. With unfavorable weather at ripening time it splits badly at the blossom end.

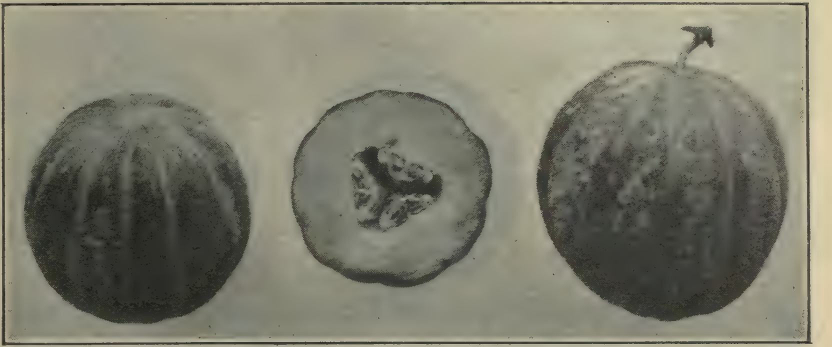

FIG. 9.—Miller Cream (*Osage*) muskmelons

(7) **Netted Gem.**—This variety is often referred to as the Rocky Ford. It is the parent type of a number of the varieties now included in the largest commercial production of the Western States. In its original form it is not a good shipper, but it is higher in table quality than some of the varieties developed from it. For this reason it is largely planted in the East for home use and local marketing. The fruits are of medium size, 4 to 6 inches in diameter, and weighing from 2 to 3 pounds; slightly oblong, rounded at the ends, ribbed, and covered with fine netting; flesh green, medium thick, fine grained, with good aroma and flavor. (Fig. 12.)

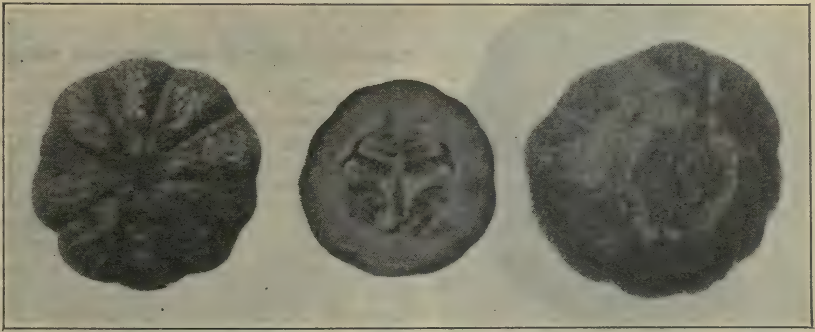

FIG. 10.—Jenny Lind muskmelons

(8) **Sweet Air** (*Knight*).—Similar to Netted Gem in size and shape except that the fruits are a little larger and a trifle more oblong; flesh rather thin, green, and having a very characteristic and decided aroma; grown extensively in the tidewater sections of Virginia and Maryland for local marketing. (Fig. 13.)

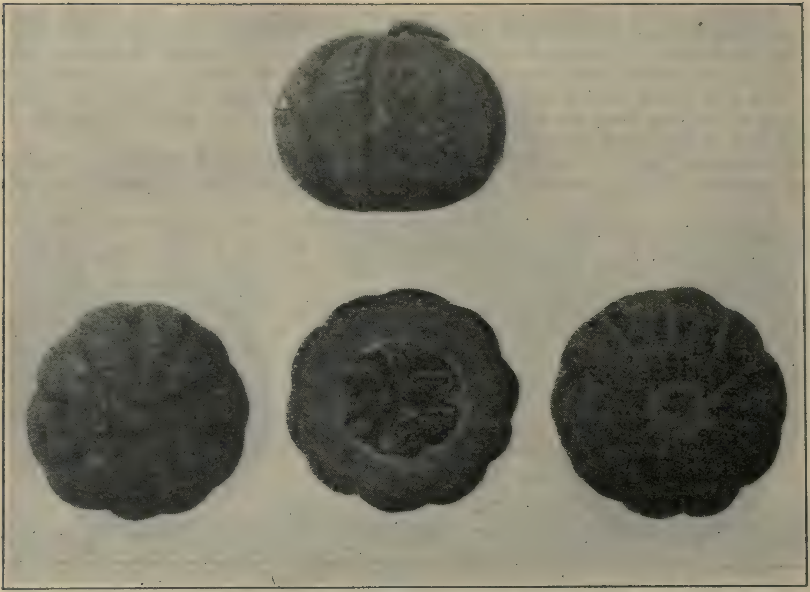

FIG. 11.—Fordhook muskmelons

(9) **Montreal Market.**—Not grown to any extent in the United States, but occasionally found on our eastern markets; globular, very large, diameter up to 12 inches, and weighing 15 to 20 pounds; deeply ribbed, coarsely netted; flesh thick, green, slightly coarse, but of excellent flavor; grown for local marketing or short-distance shipping, but it must be packed in excelsior for protection. As grown in the Montreal section the plants of this variety are started and practically grown in hotbeds, the sash and frames being removed after the weather becomes warm. (Fig. 14.)

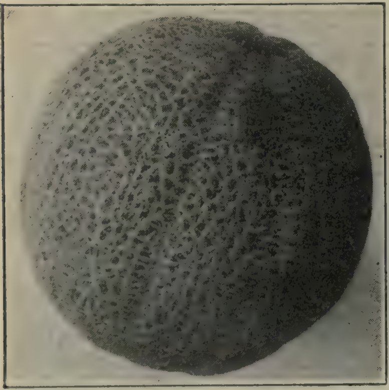

FIG. 12.—Netted Gem muskmelon, commonly called Rocky Ford

CLASS 2.—WINTER AND SPECIAL MELONS

The many varieties of class 2, comprising the Casaba, Honeydew, Christmas melon, and Santa Claus types, have been grown in Europe and Asia through a long period of time, but it is only within recent years that they have become prominent in the United States. Owing to the fact that seed of the first variety of this class is said to have come from a town in Asia Minor, near Smyrna, the name Casaba has been taken as a trade name for the whole group. Melons of this class are native to the dry region of Asia Minor and Turkestan and are therefore best adapted for growing in the hot arid sections of the Western States. Occasionally good crops can be produced in the Eastern and Southern States, but not often enough to make them profitable commercially. Melons of this class should remain on the vines until reasonably ripe and then be removed and stored in a cool, dry, well-ventilated place to complete their ripening. If not properly matured, they are lacking in flavor and sweetness and have a decided cucumber taste. The following are four of the varieties recognized in the American trade:

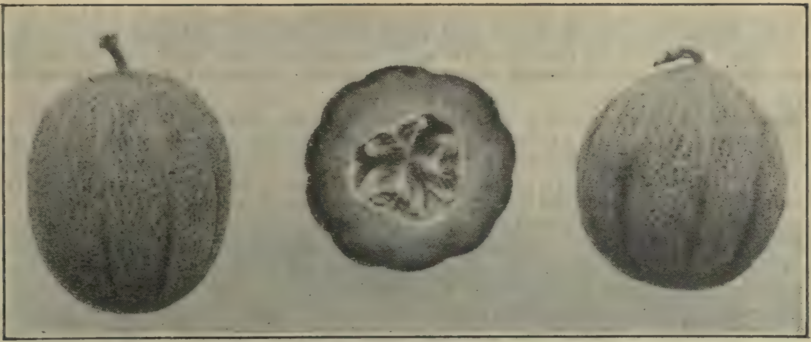

FIG. 13.—Sweet Air (*Knight*) muskmelons

Golden Beauty (*Casaba*).—Fruits large, almost globular, 7 to 10 inches in diameter, weighing 6 to 10 pounds; rind whitish green, furrowed (not ribbed) lengthwise of the melon; no netting; flesh solid, white, texture fine grained, juicy, without aroma; flavor sweet and good when properly ripened. This melon, which formerly came upon our markets during the fall and early winter, is now being grown more universally and is marketed from midsummer until late fall or until after the Christmas holidays. Casaba melons are shipped in flat crates and protected with excelsior. (Fig. 15.)

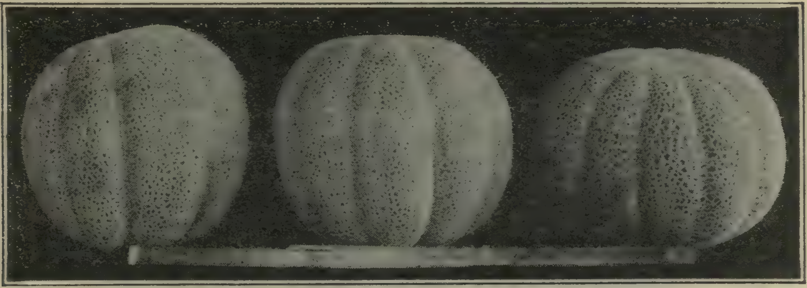

FIG. 14.—Montreal Market muskmelons

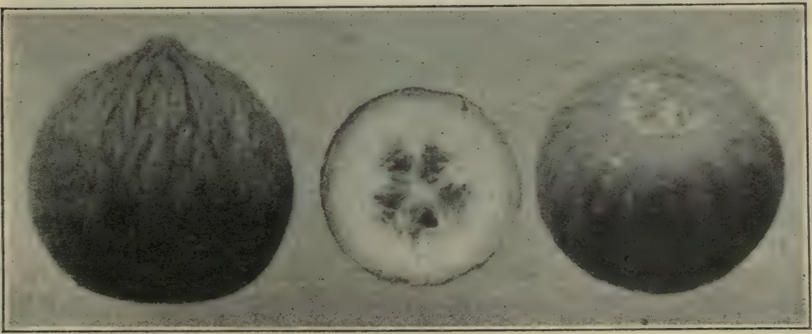

FIG. 15.—Golden Beauty (*Casaba*) muskmelons

Santa Claus (*Persian* or *Odessa*).—This is the latest and best keeper of the winter melons grown in this country. The fruits are oblong, usually 6 to 8 inches in diameter and 10 to 14 inches in length and weighing 8 to 12 pounds, often larger; rind green, very sparsely netted with broad bands; flesh very thick, fine grained, firm, white or light yellowish green, with a distinct aroma but no muskiness, flavor sweet and good when properly ripened. This variety is difficult to grow in the Eastern and Southern States and can be produced successfully in only the most favorable localities of the arid western sections. (Fig. 16.)

Honeydew.—This variety originally came from Europe, where it has long been known as White Antibes Winter. The average size is about 6 inches in diameter and 7 to 8 inches in length, weighing 5 to 6 pounds; the rind is smooth with an occasional net, greenish white, turning to a creamy yellow when ripe; flesh green, thick, fine grained, and of good quality and sweet when properly ripened; cavity medium size. This melon is not easily bruised and is a splendid keeper, but it should be shipped in crates with excelsior packing, the same as Golden Beauty. The Honeydew melon should not be planted near ordinary muskmelons or Casabas if seed is to be saved.

Banana.—The Banana variety does not belong to the winter group of melons, but it is listed for the benefit of those who desire to grow it for stock feeding or special purposes. The fruits of this melon are usually 4 to 6 inches in diameter and 8 to 15 inches in length, greenish white in color, ribbed, and without netting; flesh thick, white in color; cavity small; texture mealy when ripe; flavor rather flat, not juicy. Fair quality when gathered at the right stage of ripeness. Often grown in the South for feeding to hogs.

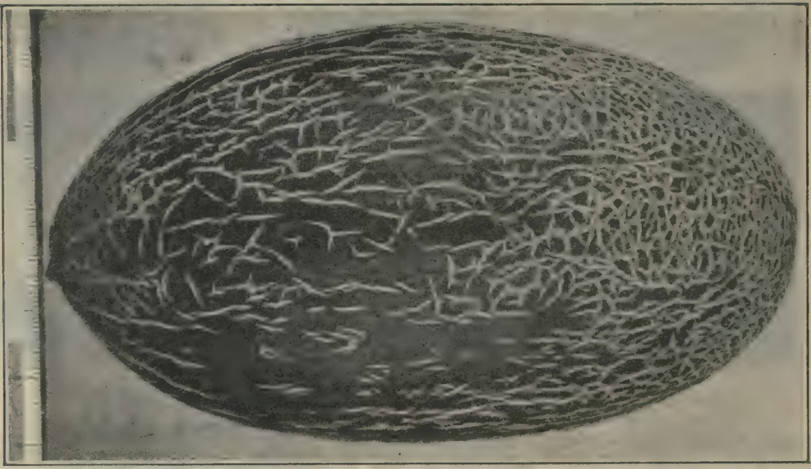

FIG. 16.—Santa Claus (*Persian* or *Odessa*) muskmelon

SEED SUPPLY

Seed that is of pure strain, true to type, uniform, and of high vitality is the first essential to the growing of a standard crop of muskmelons. Improvement through breeding and seed selection has been carried to a point where an ample supply of high-grade seed from selected melons may be obtained from dealers. Although much of the commercial supply is grown locally, great quantities of seed are produced within a limited area near Rocky Ford, Colo. The improvement in seed production in this region has been due largely to the demand on the part of associations of melon growers for seed of uniform strains, especially of types for long-distance shipment. The climatic conditions of the Rocky Ford section are especially adapted to growing melons of high quality and free from disease. Care must be taken in growing the seed to prevent the varieties mixing; in fact, but one variety should be grown in a locality. Contrary to general belief, muskmelons do not mix with cucumbers, pumpkins, or squashes, but they will mix with other varieties of muskmelons.

When grown for seed purposes the vines are carefully gone over at intervals, and all weak or diseased plants or those not true to type are removed. The melons from which seed is to be saved are allowed to become fully ripened on the vines and are selected from the standpoint of trueness to type. The seed melons are gathered into piles and either hauled to a central point for extracting the seed or the work is done in the field. One method of extracting the seed is to cut the melons at the piles, collecting the seed in pails, which are emptied into barrels on a wagon, as shown in Figure 17. Another method is by the use of a separating machine (fig. 18), which is either driven directly to the field or the melons are hauled to the machine at a central point. The seeds and their surrounding pulp are allowed to stand for a few hours in the barrels until fermentation proceeds to a point where the seeds settle to the bottom and the pulp floats to the top. The pulp is then poured off and the seeds washed with plenty of clean cold water. When large quantities of seeds are saved a special washing machine is employed. The seeds immediately after washing are spread thinly on trays having screen wire or bur-

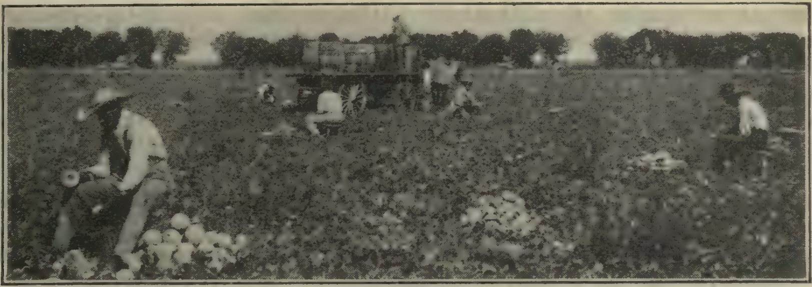

FIG. 17.—Removing seeds from muskmelons in the field

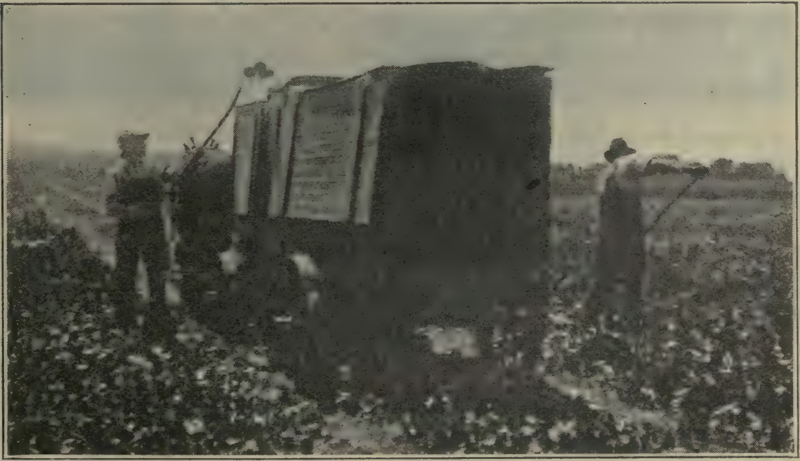

FIG. 18.—Machine for separating seeds from muskmelons

lap bottoms (fig. 19) and are stirred frequently to insure their drying quickly and evenly. After they are thoroughly dry they are bagged and stored in a well-ventilated room where they will not be molested by mice, rats, or other pests.

In saving small quantities of seed the usual method is to select uniform melons of the desired size and type from vigorous disease-free vines at the time the crop is being gathered for the market. Each seed melon is marked by tying a piece of string upon the stem. After these melons have become thoroughly ripened on the vines they are removed and kept for two or three days, so that the pulp surrounding the seeds will soften. Each melon is then cut in halves, the seeds being removed with the fingers, or the halves are given a downward jerk to extract the seeds, which fall into a pail, barrel, tub, or other wooden container. For very small quantities of seed a stoneware jar is suitable. The seeds are slightly fermented in their own juice without the addition of water and then are washed clean and dried, as already described. Growers who save their own supply of seed provide 2 pounds of seed for each acre to be planted. By doing so, a reserve supply is always on hand for replanting should it become necessary.

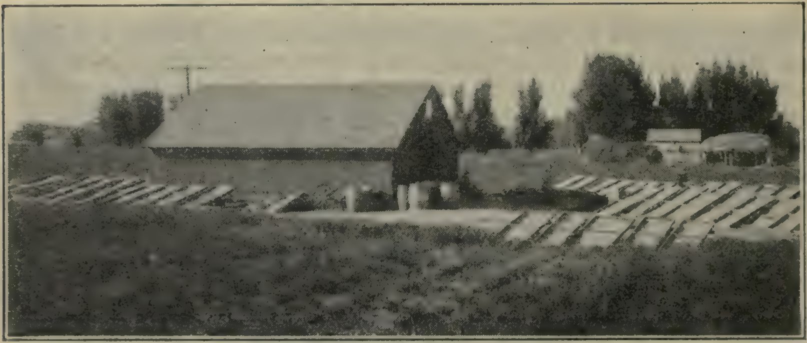

FIG. 19.—Muskmelon seeds drying on trays

Commercial muskmelon growers, especially those who are members of associations, arrange for their seed supply well in advance, usually buying it through the association managers. Long experience has demonstrated the variety and strain that gives best results in each of the commercial localities, and it is desirable that the commercial crop should always be planted from seed of a proved variety and strain.

PREPARATION OF SOIL

Careful plowing to a depth of 7 to 10 inches sufficiently early in the season to permit the soil to settle thoroughly is essential to successful muskmelon growing. Land that is in sod or on which a cover crop has been grown the previous season should be plowed either in the fall or during the winter, in order that the rough material that is turned under may have a chance to decay. In sections of the South where bedding the land is practiced the bed should be made 5 to 7 feet in width with one row planted on each bed. In order to avoid having an unbroken space in the center of the bed the land should be either rebedded two to four weeks after it is first plowed or a bull tongue run through the center of the bed to break up the soil that is not fully turned in plowing. A careful plowman, in opening the bed, can double-turn the first furrow in such a way as to break up the soil in the middle of the bed. Under normal conditions there is no advantage in bedding well-drained sandy loam soils for growing muskmelons, but on low river-bottom or alluvial soils, where the water table is near the surface, bedding is essential. In parts of the Atlantic and Gulf region where excessive rains frequently occur during the early summer it is desirable to plow the land in 5 or 6 foot beds with open furrows between to give better drainage. In the North-Central States the land is plowed in the usual manner and the melons planted on the level, or, at most, on a slight mound or hill. In districts where the crop is grown under irrigation it is absolutely necessary to bed the land to conform with the practices of the section.

During the period between plowing and the time for planting the seed the land should be thoroughly cut with a disk harrow, and prior to planting it should be gone over with a smoothing harrow. A harrow of the type known as the Acme, which crushes, turns, and pulverizes the soil at one operation, is a splendid tool for the final preparation, though its use is not necessary on extremely loose or sandy soils, where an ordinary spike-tooth smoothing harrow will do the work.

MANURE AND FERTILIZERS

Muskmelons are a rapid-growing crop and require an abundance of plant food. If stable or feed-lot manure is used in the hills or beds it should be well decayed, but that produced by feeding hay from old melon fields should not be used because of its disease-carrying tendencies. In handling the manure, it is a good plan to add 100 pounds of acid phosphate to each ton, and 6 to 10 tons of manure, where available, may be applied broadcast and harrowed into the soil. Where a manure spreader is available it can be driven astride the beds and the manure applied to a strip about 4 feet in width along the center of the bed. Where the land is not bedded the rows may be laid off in one direction and the manure applied with the spreader in the strip where the row is to be located.

Another method is to lay off the rows with a turnplow or a middle buster and then apply the manure in the furrows, spacing the small piles the correct distance for the hills (fig. 20), after which the turnplow is again used to form a slight bed over the manure. In some cases the land is first marked to indicate the distance between hills, after which the furrows are opened in the opposite direction and the manure hauled with wagons and placed in the furrows at the intersections. If the available quantity of manure is only 4 tons or less per acre, the best results will usually be obtained by applying it in the hills. Poultry and sheep manures are sometimes mixed with the soil in the hills, but as both are highly concentrated they should be used sparingly and thoroughly mixed with the soil.

Commercial fertilizers are almost indispensable for growing muskmelons on a large scale, the composition and quantity of the fertilizer depending upon the character of the soil. As a rule, a fertilizer containing 3 to 4 per cent nitrogen, 8 to 10 per cent phosphoric acid, and 4 to 6 per cent potash may be profitably used in quantities varying from 400 to 1,400 pounds per acre, the composition and quantity depending largely upon the previous cropping of the land. On soils that have been highly fertilized the previous season or on those that have grown alfalfa or a heavy crop of velvetbeans, cowpeas, or clover, 300 pounds will usually be sufficient. The nitrogen content of the fertilizer may be a little lower on lands that have grown leguminous crops during preceding years, but on land which has not been manured or upon which legumes have not been grown recently at least 800 pounds of a complete fertilizer will be required. Some of the best melon growers in the Maryland, Delaware, and New Jersey section follow the practice of applying 600 pounds of fertilizer to the acre either sown broadcast or in a strip 2 to 4 feet wide along the rows when preparing the land, following with two side dressings of 200 to 300 pounds each during the growing season. The first side dressing is drilled about a foot from the plants just when the vines begin to run, and the second is applied at the time of the last cultivation, when the vines have to be turned for the application of the fertilizer. In all cases it is extremely important to spread and mix the fertilizer thoroughly with the soil, so that the feeding rootlets will acquire it gradually.

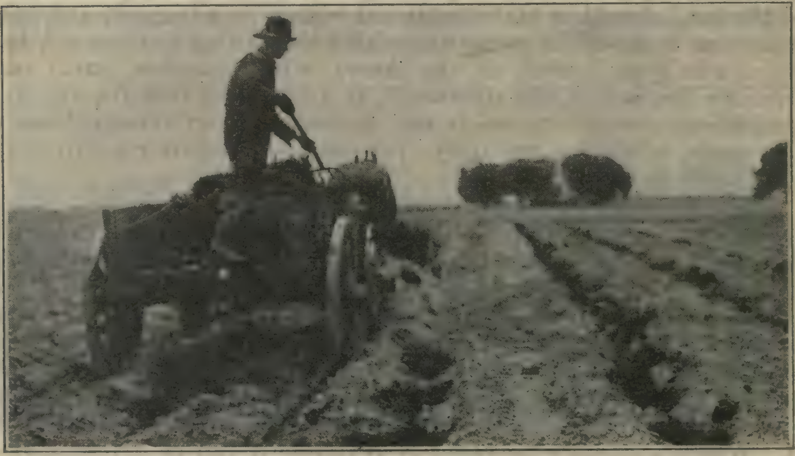

FIG. 20.—Manuring land on which muskmelons are to be planted in hills

Many growers follow the practice of scattering a small handful of fertilizer where the hill is to be made, in addition to the regular broadcast application. Some growers also place about a teaspoonful of nitrate of soda in the hills 3 or 4 inches from the young plants shortly after they come through the ground, to give them a quick start and get them beyond the tender stage. The use of nitrate of soda as a top-dressing late in the growing season is not recommended, however, as it causes the vines to make a rank growth, producing melons of poor shipping quality.

METHODS OF PLANTING

Two general systems of starting the muskmelon crop are practiced. By the first and almost universal method the seed is planted in hills or drills in the field where the crop is to be grown. The second method involves the use of greenhouses, hotbeds, or sash-covered frames for starting the plants and their transfer to the field when weather conditions are suitable. This method is adapted for small acreages only, especially where earliness of maturity is important.

Field practices in the planting of muskmelons vary considerably with the locality and climatic conditions. In the western or irrigated sections the practice of growing on raised beds is almost universal. The beds are run east and west, usually 6 to 8 feet wide, with a rather deep irrigation furrow between, made by back-furrowing with a turnplow. Following the plowing the tops of the beds are harrowed smooth to form a dust mulch, and a V-shaped furrow is run along the south edge of each bed to form a seed bed. A moderate stream is then run down the irrigation furrow to establish a planting level. The seeds are planted in hills 3 to 5 feet apart slightly above the water level, following which the hills are usually covered with transparent paper for protection. By planting along the south side of the beds the young plants get the full effect of the sun and are protected from the north winds. High beds have the advantage that the vines and melons are above the water level during irrigation.

Muskmelon growers of southern Georgia plant on beds 5 to 7 feet in width, to provide better drainage and freedom from surface water after heavy rains. As a rule, the Georgia growers plant in hills spaced about 5 feet apart in the center of the beds, but in some cases the seed is planted in a continuous row by means of a drill, the seedlings being afterwards thinned to a single plant every 2 or 3 feet in the row. On land that is rolling and liable to wash during heavy rains the beds are frequently arranged so as to follow the contour of the hillsides, each bed and intervening furrow serving as a terrace and drainage channel. Under this method of culture the hills are seldom checked, and cultivation is in one direction only.

Where level culture is practiced, as in most of the North-Central and Northeastern States, the hills are usually checked and the melons cultivated in both directions during the early part of the season. By spacing the rows 7 feet and the hills 4 to 6 feet apart in the rows, cultivation can be continued in one direction after the vines have formed matted rows. Where systematic spraying of the vines every week or 10 days is practiced the melons are trained so that a roadway every few rows is kept open for the passage of the sprayer. In some cases every sixth or seventh row is made wider than the others, to provide a roadway for the spray outfit, these open spaces serving as roads when gathering the crop.

With the hills 5 feet apart in each direction there will be 1,740 hills to the acre. Where they are 5 by 6 feet apart there will be approximately 1,452 hills. Spacing at 5 by 7 feet will give 1,240 hills, while 5 by 8 feet provides for about 1,090 hills to the acre. The most common planting distance is probably 5 by 7 feet.

A pound of muskmelon seed is sufficient for planting an acre, although many growers provide 2 pounds. An ounce of muskmelon seed of average size contains 850 seeds, 13,600 to the pound. At the usual planting distances this will provide about 10 seeds for each hill—a sufficient number. In the western sections where large acreages of muskmelons are grown, seeding is frequently done with horse-drawn gang planters, planting four rows at once. In the eastern sections single-row planters are most commonly used, or the planting is done by hand with an ordinary hoe, the depth depending upon the character of the soil and its moisture content. On irrigated lands and those soils that contain plenty of moisture the depth should not exceed 1 inch and on the light sandy soils 1½ inches. Nothing is to be gained by planting before the soil is sufficiently warm. Where the hills are covered with transparent paper, as practiced in the Imperial Valley of California, the seed can safely be planted a little earlier than where no covers are used.

Greenhouses and hotbeds are used to a limited degree for starting muskmelon plants, especially in the intensive market-garden sections where land values are high and extreme earliness of the crop is desirable. By starting the plants under cover with artificial heat the ripening of the melons can be hastened from one to two weeks and the period of production lengthened. The usual method of growing the plants is by means of manure hotbeds, flue-heated beds, or greenhouses. In numerous instances growers have constructed permanent concrete beds with hot-water heating equipment for general plant growing, including the starting of muskmelons. As only a moderate heat is required for starting muskmelon plants, a hotbed having about 8 inches of manure or one used for starting earlier plants may be used. Manure-heated beds are usually constructed 6 feet in width and covered with standard 3 by 6 foot hotbed sash. Difficulty in getting manure suitable for hotbeds has led many growers to adopt the flue-heated bed or small greenhouse for growing the plants.

Flue-heated beds are as a rule about 12 to 16 feet in width and 40 to 50 feet in length, with a brick or stone furnace placed underground at one end of the bed. Two, sometimes three, flues of tile or brick run the full length of the bed beneath the board floor and terminate in separate chimneys at the farther end. The sides of the bed are usually of 2-inch plank, and a framework of 1 by 3 inch lath is used to support the unbleached muslin or light canvas covering.

Veneer wood bands, paper plant bands, quart berry boxes, and small squares of sod are frequently used for starting the melon plants in the beds. In some cases no containers are used, but a layer of rich loam about 4 inches thick is spread evenly over the bed and slightly firmed. The surface is then marked about 5 inches each way and seven or eight seeds planted in each of the squares. When the plants are ready to transfer to the field the bed is watered and a knife run between the hills, cutting the soil into cubes that may be lifted by means of a square-pointed trowel. Veneer bands made of wood 4 by 4 by 3 inches hold their shape better than those made of paper. The sodding method is an old and very good one, but it involves more labor than is entailed by the use of the veneer or paper bands. The sod is cut into small squares 4 by 4 or 5 by 5 inches and 2½ or 3 inches thick and placed close together in the bed with the grass side downward. A little fine sifted compost consisting of rotted manure and good loam is then worked into the root side of the sods, and seven or eight seeds are planted in each inverted sod.

Muskmelon plants grown in beds or greenhouses require careful attention to watering, ventilating, and thinning. A temperature of 70° to 75° F. should be maintained until the seeds germinate, after which a day temperature of 65° to 70° and a night temperature of 60° to 65° F. will be about right. Plenty of ventilation should be given, to keep the plants short and stocky. Toward the end of the period that the plants remain in the beds the covers should be left off most of the time, to harden them to outdoor conditions. Greenhouses are not desirable for starting melon plants unless they are capable of being very freely ventilated.

Four to five weeks is the limit for keeping the muskmelon plants in the greenhouse or beds, and the time for sowing the seeds should be carefully determined with relation to the average frost-free date for the section. Nothing is to be gained by too great haste, and it is much better to have young and thrifty rather than overgrown plants ready for setting. Thinning the plants to three or four in a hill should be done as soon as they are up. After they are moved to the field and become established they are thinned to two plants in a hill. Missing plants may be replaced by carefully transplanting those removed from other hills, but a narrow trowel should be used and a small quantity of soil kept on the roots of the plants thus moved.

A warm calm day should be selected for shifting the plants from the beds to the field. The beds should be watered several hours in advance and the foliage allowed to dry. As the plants are lifted they are placed on boards or in trays, loaded into a cart or wagon, and hauled to the field. The land should be in readiness and marked in one direction, and the furrows in which to set the plants should be opened only as needed. In setting, it is customary to place the hills just a little below the general level of the ground, for protection; then later to fill in around the plants.

Plants of the Montreal muskmelon, which is grown in the Montreal district of Canada and also to a limited extent in Vermont, are started in hotbeds and later the beds removed, allowing them to remain where originally planted. By this method the vines make considerable growth in the frames and the necessary extension of season is thereby gained.

THINNING IN THE FIELD

Planted in the field by the ordinary method, muskmelons require careful thinning, as a much larger quantity of seed is used than is necessary. When the plants show a small leaf between the seed leaves they should be thinned to about four to a hill and in about a week or 10 days again thinned to two in a hill. In sections where the striped cucumber beetle is especially troublesome the final thinning is usually delayed until the plants are well established and have formed three or four true leaves. Where the plants crowd closely together in the hills they should be separated as much as possible in thinning; and if there is danger of disturbing the roots of the remaining plants those that are removed should be cut off rather than pulled out. In continuous-row planting, the plants are finally left singly 2 to 3 feet apart in the row.

CULTIVATION

The cultivation of muskmelons should begin as soon as the rows of plants can be followed, and the soil should be loose and mellow and kept free from weeds until the spread of the vines makes further working impracticable. It should be borne in mind that the muskmelon is a comparatively shallow rooted plant and that the roots often extend farther than the vines. It is therefore essential that the land be worked shallow, especially near the hills and after the vines begin to run freely. Where the hills are carefully checked cultivation can be given in both directions during the early part of the season by means of a weeder or any shallow-working cultivator. Many growers work along the rows with a 1-horse walking cultivator or with a 2-horse riding cultivator and then break the middles with a harrow. When the plants begin to spread cultivation should be carried on in one direction and the vines kept trained in a more or less compact row. During the last cultivation the vines are sometimes turned back by hand or a vine lifter is attached to the cultivator in order to work closer to the plants. At this time the second and final side dressing of fertilizer is applied and worked into the soil. Following the last cultivation the tips of the vines should be spread evenly in all directions and the growth allowed to cover the entire space between the rows.

Hand hoeing will be required early in the season while the plants are small and at intervals after the vines have begun to develop, in order to remove weeds that can not be destroyed in horse cultivation. About six workings with horse-drawn tools and two to four hand hoeings will be required properly to grow a crop of muskmelons.

NIPPING AND PRUNING VINES

Frequent inquiries are made by growers as to the advisability of nipping or pruning muskmelon vines, with the object of increasing the set of fruit or of hastening its development. Early writers on muskmelon culture gave specific and detailed instructions regarding the nipping of the vines, this advice evidently being based upon European practices in connection with growing the crop under glass and in restricted areas. The theory of these writers was that the nipping of the main vine caused the early formation of the laterals on which the crown setting or first fruit is borne. The results of experiments conducted by the Illinois and New Hampshire Agricultural Experiment Stations show conclusively that there is little, if anything, to be gained from pinching or heading back muskmelon vines when grown out of doors under the conditions involved in their experiments.

Reducing the number of muskmelons on a vine will increase the size of those that remain, but in view of the fact that most varieties produce melons too large for a standard pack the thinning of those on the vines will prove a loss rather than a gain.

POLLINATION

Growers frequently inquire why the early blossoms on their muskmelons do not set fruit. Muskmelon blossoms are of two kinds, staminate and pistillate, or male and female. Following the natural tendency of all vine crops, a large number of male blossoms appear in advance of the smaller number of female blossoms, which accounts for the apparent failure of the vines to set fruit. At the base of the pistillate or female blossom is located the small embryonic melon formed before the blossom opened, and it is necessary that the pollen from the male flower be transferred by bees or other insects to the female flower. Where melons are grown in greenhouses or in closed frames it is essential that provision be made for the entrance of bees in order that the pollen be transferred.

IRRIGATION

Muskmelon vines require an abundance of moisture during the period when they are making the strongest growth and up to the time that the melons are full grown, but great care should be taken to avoid overwatering just preceding and during the ripening period. The deep rooting and vigor of the vines are possible only under conditions where the necessary moisture is supplied without oversaturation of the soil. In sections where furrow irrigation is practiced and the muskmelons are grown on raised beds the vines are kept upon the beds (fig. 21), the furrows remaining open. Short heads and quick applications of the water, followed by drainage of the irrigation furrows, give the best results. Where it is necessary to irrigate before the plants are up care should be taken that the flow does not go over the top of the hills but that the water soaks beneath the hills, leaving the surface dry.

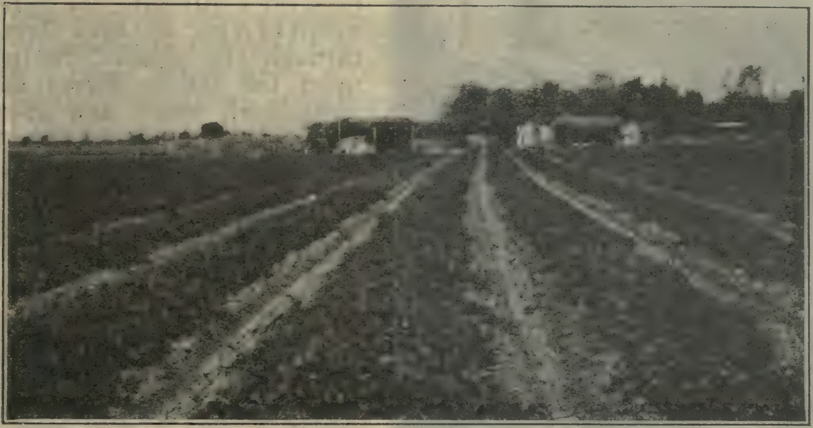

FIG. 21.—Muskmelons growing on raised beds with irrigation furrows between the beds

In regions having normal or natural rainfall during the melon-growing season there are frequent periods during which irrigation proves a decided advantage. The water is sometimes applied by running a small stream in a shallow furrow along the rows, but more often by means of overhead or sprinkler irrigation systems. Here, again, a careful study of soil conditions and weather prospects is essential from the standpoint of both the cost and the effect of the water upon the growing crop. Where irrigation is followed by heavy rainfall the watering is often harmful, reducing the yield of marketable melons.

INSECT ENEMIES[1]

STRIPED CUCUMBER BEETLE

Growers must be prepared to combat the insects that attack muskmelons. Of these the striped cucumber beetle and the melon aphis, or louse, are widespread and are the cause of serious damage to the melon crop in many States. The striped cucumber beetle emerges from winter quarters in late spring or early summer and usually appears in the melon fields in vast numbers, often attacking the melon seedlings as they break through the ground, feeding upon the tender leaves and stems both below and above the surface, gaining access to the underground stem through the cracks in the soil. They are particularly active at this period and unless checked may destroy large plantings in a few days.

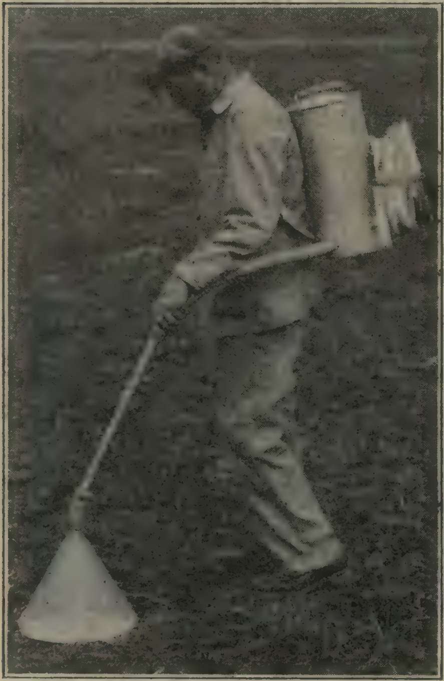

FIG. 22.—Applying nicotine dust to melon hills by means of a dusting apparatus with a funnel attachment

To control successfully the striped cucumber beetle the grower must be on the lookout for its first appearance. An effective means of control is the use of nicotine dust, usually a combination of hydrated lime and nicotine sulphate. The nicotine contained in the dust acts as a fumigant and kills when brought in contact with the insect. A dust containing 2 per cent nicotine (5 per cent nicotine sulphate) applied at air temperatures above 70° F. has proved satisfactory. When the dust is applied directly to hills of small melons 15 to 20 pounds are sufficient to cover an acre. The best results are obtained by timely dustings, and the first application should be made as soon as the beetles are observed, which is about the time early plantings appear above the ground, followed by as many treatments as may be necessary to prevent further injury.

Dusting young melons with hand-operated dusters having a galvanized cone attached to the outlet pipe (fig. 22) has proved to be both effective and economical. In operation the cone is placed over the hill, the duster operated, and the cone allowed to remain over the hill for a few seconds, thus preventing the beetles from escaping while the dust is concentrated upon the hill.

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[1] Prepared by the Office of Truck-Crop Insect Investigations, Bureau of Entomology, United States Department of Agriculture.

The writer has observed that the muskmelon growers of the Hurlock district, on the Eastern Shore of Maryland, apply nicotine dust to young melon plants by the use of small hand box dusters (fig. 23). The box portion of this duster is 8 or 10 inches square on the outside and 12 inches deep; inside of this is suspended a close-fitting cheesecloth or burlap bag from which a small quantity of the dust is sifted upon and around the young plants as the box is dropped down over the hill, thus completely trapping the insects. As the operator walks along the row the duster is dropped over each hill and allowed to remain a second or two. Then it is moved to the next hill, with only a short pause in the stride of the operator. Tightly covered cans containing a supply of the dust from which to replenish the small dusters should be placed at convenient points in the melon field. One man will cover from 8 to 10 acres a day with one of these hand dusters.

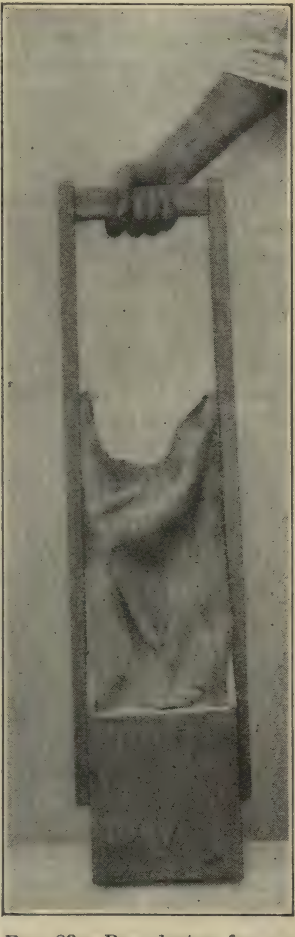

Fig. 23.—Box duster for applying nicotine dust for control of striped cucumber beetles on muskmelon plants

The University of Maryland[2] has devised a box fumigator which has been used with success in treating young melons with nicotine dust for the control of the striped cucumber beetle. The box is constructed of light wood 12 or 14 inches square and 10 inches deep, with the bottom open and the top closed by a hinged lid. Two uprights with a crosspiece at the top are attached to the sides of the box, to form a handle. The dust is suspended in the box by means of a piece of burlap fitted across and extending down to within 4 inches of the lower edge.

In operation, 12 of these fumigator dusters are placed one each over the first 12 hills of melons at one corner of the field. As soon as the 12 boxes are in position the operator returns to the starting point and moves them, one at a time, to the adjacent row. About two minutes will be required to make the change, during which the dust and the gas are concentered and kill a high percentage of the insects. If there is no loss of time one man will fumigate from 360 to 420 hills of melons in an hour by this method.

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[2] Cory, E. N., and Potts, S. F. The control of truck crop pests by dusting. Md. Agr. Exp. Sta. Bul. 261, p. 121–155, illus. 1924.

Arsenicals used separately or combined with Bordeaux mixture, applied either as a dust or spray, aid materially in preventing damage by the striped cucumber beetle. Injury may also be checked to a limited extent by liberal applications of hydrated lime.

MELON APHIS

This melon aphis is a small louselike insect which obtains its food by sucking the plant juices. It feeds on the under side of the leaf and when abundant causes the leaf to curl, lose color, and finally die. Infestation of melon fields is started by winged females, which fly from other food plants. They start in the early summer as small colonies on the under side of the leaf. Unless checked they soon spread over the entire plant and thence to adjoining hills until the whole field is infested.

To combat the melon aphis successfully a close inspection of the field should be made from time to time, in order that the first appearance of the insects may be noted and means taken to check their spread. Unless this is done, the infestation may become so widespread and severe that control measures will be of little value.

Nicotine dust containing 2 per cent actual nicotine used at the rate of 30 to 40 pounds per acre on fully grown plants will control this pest. For the best results the dust should be applied when the air temperature is above 70° F. and when the foliage of the plants is dry. A hand duster may be used with success on small areas and the dust applied in such a manner that it will reach the under side of the leaves. Plants immediately adjacent to those heavily infested should also be dusted in order to kill any aphids that may have spread from the original colony. Where the infestation has become general and the area is large, power or traction dusters may be used to advantage.

Spraying with nicotine sulphate to control the melon aphis has been found effective when the solution is made as follows:

Nicotine sulphate (40 per cent nicotine)	⅜ pint
Soap (laundry or fishoil soap)	2 to 4 pounds
Water	50 gallons

For small areas, use 1 teaspoonful of nicotine sulphate and 2 ounces of soap to 1 gallon of water.

The object of the soap is to make the spray spread evenly over the foliage, and more soap is required for hard water than for soft. In case the spray draws together in small globules, leaving uncoated areas on the foliage, more soap should be added. It must be borne in mind that it is essential that the spray or dust actually strikes the body of the insect.

For further information on the control of insects injurious to the melon crop, write to the Bureau of Entomology, United States Department of Agriculture.

DISEASES AND THEIR CONTROL[3]

Muskmelons are subject to a number of diseases that may be either avoided by planting on clean land or losses from them reduced by seed treatment or by spraying or dusting.

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[3] Prepared by W. W. Gilbert, Pathologist, Office of Cotton, Truck, and Forage Crop Disease Investigations, Bureau of Plant Industry.

Root-knot[4] is caused by minute eelworms, or nematodes, which attack the roots of muskmelons and many other garden crops under certain conditions, causing swellings, or galls, upon the roots, which produce dwarfing of the plants and prevent the maturing of good crops. This trouble is often very serious in the sandy soils of the South but is rarely of importance in the North. Crop rotation and the planting of melons only on land free from nematodes are the best methods of control now known.

Bacterial wilt is a fairly common disease of muskmelons and is caused by bacteria living in the water vessels of the roots, stems, and leaves. This disease is similar in appearance to the wilting caused by lack of water, though it usually appears more suddenly and may affect only one runner of the plant. Death of the plant soon follows this wilting, and sometimes serious losses result.

Bacterial wilt does not live in the soil but is carried over winter by the striped cucumber beetle and is spread from plant to plant by this insect and possibly by other insects. Rigid control of these insects by methods given on page 22 will materially aid in controlling wilt. In addition, wilted plants found early in the season should be promptly pulled and burned or buried.

Mosaic is a widespread and often serious disease, characterized by mottling, yellowing, and curling of the leaves, dwarfing of the plants, and reduction in the number, size, and quality of the fruits. Like similar mosaic diseases of other plants, it is caused by a virus which is spread in the juice of diseased plants, carried by insects—chiefly striped cucumber beetles and aphids—and by the pickers. It is carried over winter in the seeds of the wild cucumber and in the perennial rootstocks of milkweed, pokeweed, and other plants, but not, so far as known, in the seeds of the muskmelon. The best control measures known include the prompt removal of young diseased plants, the digging up and burning of wild cucumber vines, milkweed, pokeweed, and other overwintering host plants in and near the melon fields, and the control of the insects which spread the disease.

Three important diseases—anthracnose, downy mildew, and blight—all ordinarily called "blight" or "leaf-spot," may attack the muskmelon when weather conditions are favorable, frequently resulting in heavy losses. All three diseases are caused by fungi. They develop and spread rapidly in moist warm weather and are characterized by brownish more or less rounded spots, which enlarge and soon cause the leaves to turn yellow, curl, dry up, and die. The stems are likewise attacked and the plants prematurely killed. One of these diseases—anthracnose—also causes sunken decaying spots on the fruits. Melons from fields severely attacked in midseason by any of these troubles are usually undersized and lacking in sweetness and juiciness.

Crop rotation, seed treatment, and spraying are important means of reducing losses from anthracnose, downy mildew, and blight. Muskmelons should not be planted in or adjacent to land where diseased vine crops were grown the previous year, as the causal fungi of two and possibly all of these diseases live over winter in the soil. As a precaution against seed transmission of these diseases, especially anthracnose, the seed should be treated for five minutes in a 1 to 1,000 mercuric-chloride solution, followed by thorough washing in water. Spraying the vines with Bordeaux mixture will materially check the development of all three diseases, often permitting the harvesting of a profitable crop.

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[4] Growers who are suffering losses from root-knot on melons or other crops should consult Root-knot: Its cause and control. U. S. Dept. Agr., Farmers' Bul. 1345, 27 p., illus. 1923.

Dusting with copper-lime fungicidal dusts is being tested, in some instances with good results, but it is still in the experimental stage. Its principal advantages are quicker and easier application; its main drawbacks are the greater cost of material and in some instances reduced effectiveness in disease control.

Spraying is a preventive rather than a cure for fungous leaf diseases. Successful control is secured only when the work is started early in the season before the diseases appear and is done carefully and thoroughly with a high-pressure pump, so that all parts of the plants are coated with a fine mist of the spray mixture. It is essential also that the Bordeaux mixture should be properly made and applied at intervals frequent enough to cover the new growth promptly.

For spraying, where any considerable acreage is involved, a power outfit should be used and a Bordeaux mixing platform constructed. A convenient method is to erect a wooden platform large enough to hold at least six to eight barrels and high enough to permit the solutions to run by gravity from the mixing barrels into the sprayer tank. It should also be near an ample supply of water. Stock solutions of copper sulphate (bluestone) and lime should be made in separate barrels, the usual strength being 1 pound to the gallon. To make up 100 gallons of 4–4–50 Bordeaux mixture, place 8 gallons of bluestone stock solution in a 50-gallon barrel and fill it with water. Likewise, after thorough stirring place 8 gallons of lime stock solution in a second 50-gallon barrel and fill with water, and by means of pieces of hose connected to the bottoms of the barrels allow the two solutions to run together through an 18-mesh copper-wire strainer into the spray tank. Thorough mixing of the two dilute solutions gives the best Bordeaux mixture. It should be used immediately, as it deteriorates with age.

A simplified method of making Bordeaux mixture is being used to a considerable extent, apparently with good results, and appeals to many growers because of the fact that no mixing platform is required and only sufficient barrels to hold the stock solution, unless water storage is necessary. By this method of making 100 gallons of 4–4–50 Bordeaux mixture, 8 gallons of stock solution of lime (or 12 pounds of hydrated lime) are put directly into the sprayer tank, which is then filled three-quarters full with water and the agitator run to mix it thoroughly. Eight gallons of copper-sulphate stock solution are then added and the tank filled with water. In some instances a weaker Bordeaux mixture (2–4–50) is recommended, particularly in localities where vine injury has resulted from the stronger solution.

The first spray application should be made when the plants are small, before or just as soon as the very first signs of disease appear. Other spray applications should follow at intervals of 7 to 10 days in rainy weather and 10 days to 2 weeks in hot dry weather until the melons are harvested. A similar schedule should be followed if dusting is used.

GATHERING AND HANDLING

The successful marketing of muskmelons depends largely upon careful gathering and handling. As the time for the ripening of the melons approaches, the vines of about every tenth row should be laid carefully together (fig. 24) to form roadways for the wagons or trucks, which are driven astride of these rows. Where every seventh to tenth row has been spaced wider in planting than the others in order to accommodate the spray outfit, these spaces are used as roadways for hauling the melons. In some cases the vines of two adjoining rows are turned to form a roadway between the rows.

Various types of wagons are used for hauling the melons from the field to the packing shed or to the shipping station. In orchard sections the flat-top orchard wagons when available are frequently employed, but more often the work is done with ordinary farm wagons provided with bolster springs. In all cases where melons are hauled in bulk the wagon beds should be provided with a layer of straw 3 to 4 inches deep and the sides padded with several thicknesses of burlap securely nailed over the edges to prevent injury to the melons. The use of small motor trucks for handling the melons is becoming more common, and these as a rule can be driven through the melon fields with less injury than ordinary wagons.

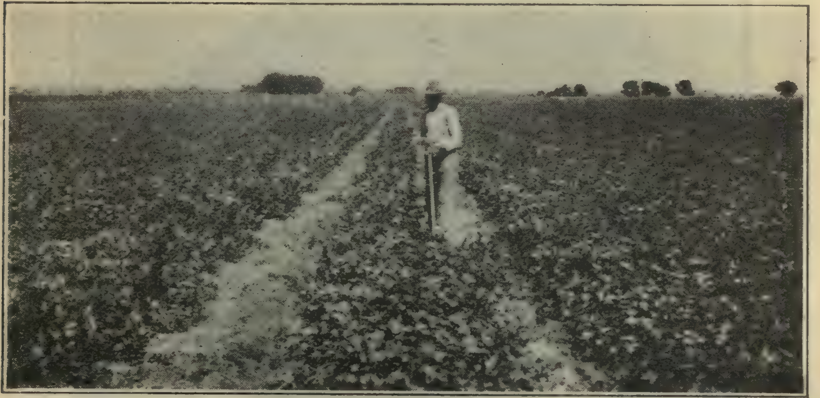

FIG. 24.—Laying muskmelon vines together, so that wagons or trucks can be driven astride of the row

Observations show that a considerable percentage of the muskmelons shipped to the principal markets of the United States are picked too green and that the sale of muskmelons is injured through the marketing of these immature melons. The experience of the best growers and dealers, as well as tests conducted by the Department of Agriculture, show conclusively that muskmelons do not attain their highest flavor and best edible qualities unless allowed to become reasonably ripe on vigorous disease-free vines. Careful transportation experiments[5] have shown that muskmelons grown in the Imperial Valley of California to be shipped under refrigeration to the most distant eastern markets of the United States may remain on the vines until ripe enough for the stems to separate from the melons under a decided pressure of the thumb and yet reach the consumer in excellent condition. Two stages of maturity were included in these experiments, the one known as "full slip," illustrated in Figure 25, by which the entire stem separates from the melon, leaving a clean stem cavity, and the other, known as the "half slip," illustrated in Figure 26, by which about one-third of the stem remains attached to the melon. In both cases the melons were full netted, and the background color had changed from a green or cucumber tinge to a slightly lighter color, but in no case yellow. In the shipping test already referred to, the melons were in transit 14 days to New York under refrigeration and did not ripen to any extent during that period. Those that were picked at the full-slip stage were in prime condition for eating on their arrival in New York, whereas those in the half-slip stage required a longer time to reach prime condition, and such prompt handling was not necessary. The claim made by growers that the melons must be gathered before they will separate from the stems has been responsible for the stocking of the principal markets with muskmelons of poor flavor and inferior eating quality. The shipment of full-slip melons, however, calls for very prompt and careful handling and it is recommended only for production areas which ship under refrigeration or which can place their product in the hands of the consumer within 48 hours from the time of picking in case refrigeration is not provided.

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[5] McKay, A. W., Fischer, G. L., and Nelson, A. E. The handling and transportation of cantaloupes. U. S. Dept. Agr., Farmers' Bul. 1145, 20 p., illus. 1921.

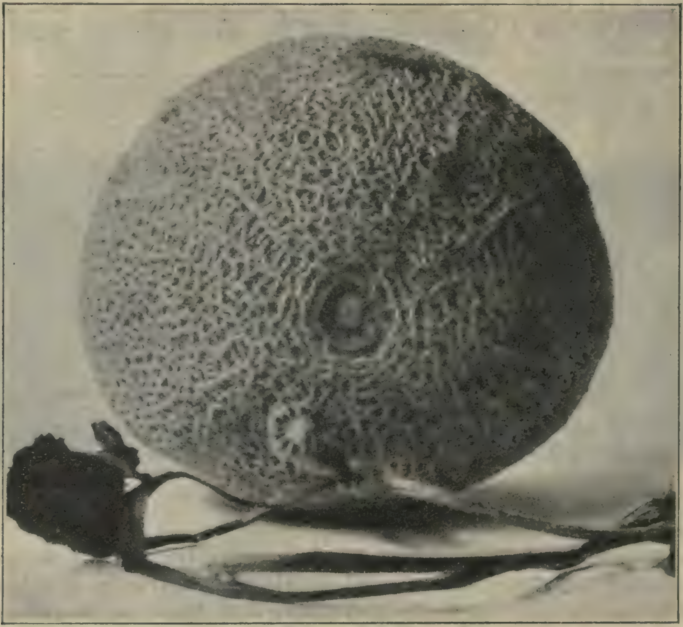

FIG. 25.—An illustration of the term "full slip" used in picking muskmelons. Note how the stem pulls away from the melon, leaving a clean, cuplike hole

Muskmelons picked at the half-slip stage are generally ready for eating in 36 to 48 hours after reaching the market, depending on the method of transportation and the weather conditions. For example, the melons that were 14 days on the way from California under refrigeration probably suffered less exposure in transit than shipments without refrigeration from the Eastern Shore of Maryland, which normally arrive in New York within 24 to 30 hours from the time they are gathered. It is desirable for the melons to reach on the vines the greatest degree of maturity that is consistent with the method of handling, but there is always the danger of overstocking the markets with soft melons, particularly at the end of the picking season, when the melons ripen rapidly. In order to satisfy the consuming public with melons of high quality it should be the aim of every grower and shipper to place upon the table of the consumer the type and quality of melon that he would want upon his own table.

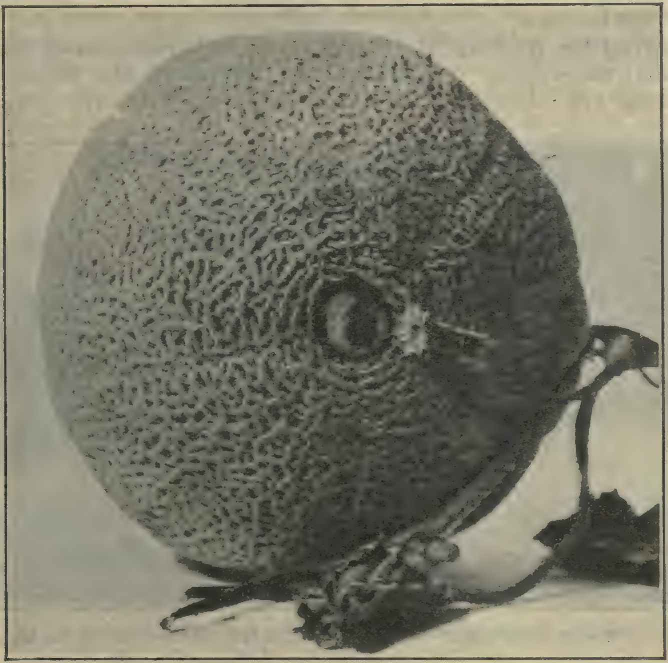

FIG. 26.—A muskmelon picked on half slip. Only a part of the stem has slipped from the melon easily, leaving the depression on the right side, the other part having broken. As a rule, this condition signifies a less degree of ripeness than the full slip

At the beginning of the picking season the melons should be gone over about every other day for the first week and every day the second week. Toward the end of the season the picking becomes continuous, and the oftener the vines are gone over and the ripening melons gathered the better. The first melons mature slowly, and as the season advances the ripening becomes more rapid, but their maturity can be readily determined by the ease with which they separate from the stems. Experienced pickers soon learn to recognize the stage of ripeness by the general appearance of the melons, mainly the background or skin color beneath the netting, and after one or two pickings are able to judge almost entirely by external characteristics.

The proper method of removal from the vine is to place the hand upon the melon, pressing upon the stem with the thumb or slightly lifting the melon from the ground. If it is sufficiently ripe the stem will separate under the pressure, showing that the melon is ready for gathering. Hampers, bushel baskets, crates, lug boxes, and numerous other types of containers are used for carrying the melons to the roadways; in some cases no picking containers are used, the melons being laid in piles. Canvas bags with shoulder straps are used extensively, but their tendency to bruise the melons is greater than that of baskets or crates. As a rule the melons are left in the picking baskets at the roadways until they are loaded into the wagons, and they are usually hauled to the packing sheds in these containers.

Following the picking, the crates or baskets containing the melons are loaded on wagons or trucks driven through the fields. Where the melons are placed in piles two men work on the ground and toss the melons to men or boys, who place them in bulk in the bed of the wagon or truck. This practice is objectionable, and the handling of the melons in field baskets or crates is recommended. After the melons are gathered no time should be lost in removing them to the packing shed, as exposure to the heat of the sun in the field causes them to soften very rapidly.

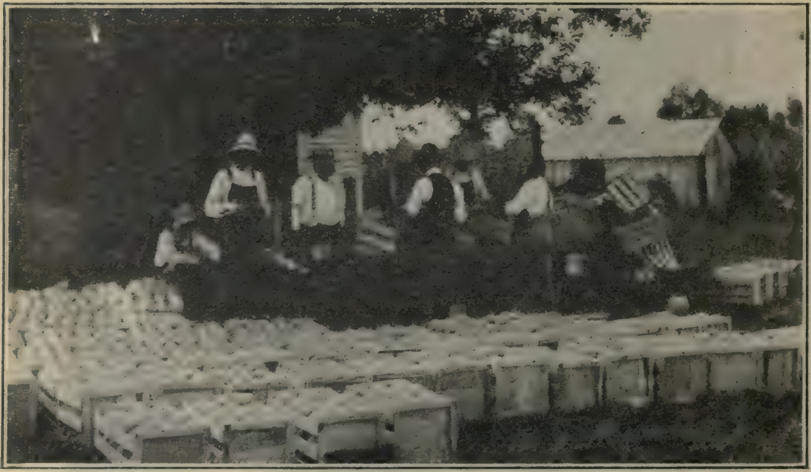

FIG. 27.—Packing muskmelons in the shade of a tree at the side of the melon field

In the past, grading and packing the melons has been done in the shade of a tree, as shown in Figure 27, or under a temporary shed constructed of boards or of poles and tree branches located at some convenient point in the melon field, as shown in Figure 28. During recent years there has been a rapid development of the central packing-shed idea. By this method a suitable building is provided at a convenient point, usually on a railway siding, and the melons are hauled from the field to this shed, where they are graded, packed, and loaded direct into the cars. There is much to recommend this plan, as a more uniform grade and better pack can be had than where the work is done in the field. Where melons are handled by trained workers under the direction of a competent superintendent, the necessity for hauling the shipping crates to the farms and back again to the shipping point is eliminated, and as a rule the packing can be done at lower cost than on the farms. Where the melons are hauled any considerable distance from the field to the packing shed they should be protected from the sun with a canvas wagon cover. As the wagons or trucks arrive at the packing shed the melons are unloaded as near as possible to the grading tables. In case the melons are hauled in bulk the packing shed should be so arranged that the melons can be placed directly on the grading tables or on a traveling belt which will convey them to these tables. Usually the graders work on the receiving side of the table, where the melons come from the wagons, while the packers are on the opposite or car-loading side, and the crates as packed are shifted from the packing table to low benches, where the covers are nailed on. The efficiency of a melon-packing shed depends largely upon the proper arrangement of the equipment and the organization of the working force. The apportionment of labor should be such that all hands are continuously at work and the melons are kept moving steadily toward the refrigerator car from the time they are received from the field wagons or trucks.

FIG. 28.—Temporary packing shed constructed at one side of a muskmelon field

GRADING AND PACKING[6]

Muskmelons are shipped to the markets of the United States in a variety of packages, but those grown in California, Colorado, and Arizona are shipped in crates known as standard, pony, and flats. The standard crate (fig. 29) is 12 by 12 by 22½ inches; pony crates are, as a rule, 11 by 11 by 22½ inches; and flats (figs. 30 and 31) are 4 or 4½ by 13 by 22½ inches, inside measurement. In the East, where no standard crate dimensions have been adopted, there is considerable variation from the above. Crates used by the western growers are usually constructed with solid ends and sawed slats, while those used by the eastern growers have paneled ends and either sawed or veneer slats. In southeastern Virginia and a number of other sections along the Atlantic coast, where the size of the melons grown is usually larger than those of the Western States, a crate similar to a 32-quart berry crate, as illustrated in Figure 32, is often employed. The famous Montreal market muskmelons are shipped in a special type of basket and packed in excelsior or in hay, as shown in Figure 33. Honeydew and Casaba melons are shipped in various sizes of flat crates. However, two sizes are now being adopted, these being 6½ by 16½ by 22½, known as the standard, and 7½ by 16½ by 22½, which is known as the jumbo. In some of the Eastern States a 12-quart Climax basket, shown in Figure 34, is used. Hampers and bushel baskets are used to a considerable extent for local marketing.

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[6] Detailed information on this phase of the subject may be found in the following publications of the U. S. Department of Agriculture: Farmers' Bulletin 707, The Commercial Grading, Packing, and Shipping of Cantaloupes, and Farmers' Bulletin 1145, The Handling and Transportation of Cantaloupes.

The large markets of the United States have come to recognize a pack consisting of 45 melons to the standard 12 by 12 by 22½ inch crate. To make this pack it is necessary that the melons be 4 or not exceeding 4½ inches in diameter and 4 to 4½ inches in length. This pack (fig. 29) has a depth of three layers, each layer containing three rows of five melons each, the melons being placed end to end and completely filling the length of the crate. Slightly larger melons are often packed 36 in the standard crate. Extra large melons or those over 5 inches in diameter are usually packed in jumbo crates, the arrangement varying according to the size and shape of the individual melons (fig. 35). The jumbo packs may consist of 36, 33, 27, or 24 melons, according to their size. In many sections the pony crate is not used, but the small melons are packed 54 to 60 to a standard crate, and when too small to pack 60 are as a rule discarded. Flat crates are packed with 9, 12, or 15 melons to a crate, according to the size of the individual melons.

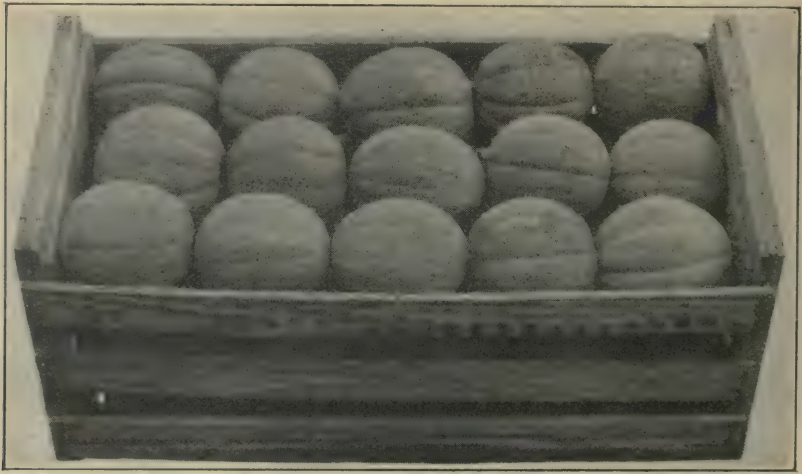

FIG. 29.—Standard crate containing 45 muskmelons; standard grade and pack

Certain growers in the eastern Maryland and Delaware district are using a special crate 9 by 13½ by 19½ inches, inside measurement, or 10 by 14 by 22 inches on the outside. A special bushel basket having straight sides and a removable bottom, which is packed from the bottom by inverting on the packing table, is also being used in the eastern section. The growers using this special basket report that it is easy to pack and adapted for handling melons which vary in size. These containers are shown in Figure 36.

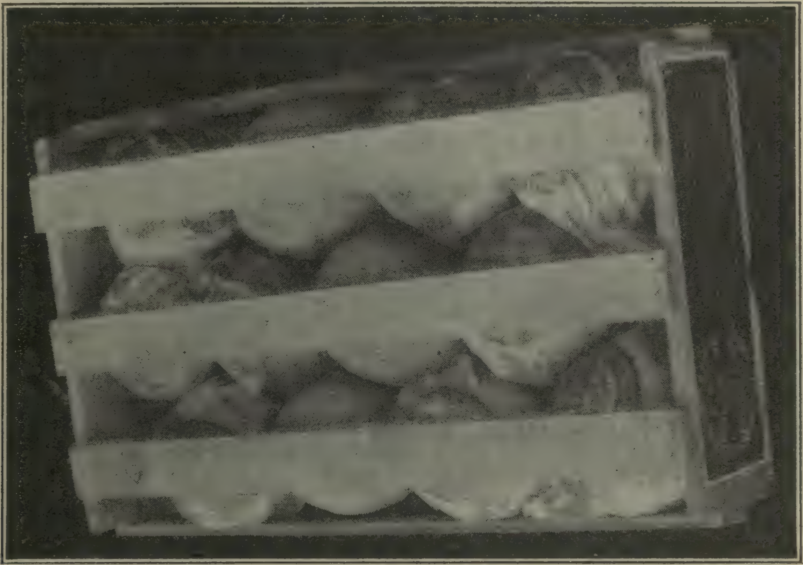

FIG. 30.—Standard flat crate holding 9 to 15 muskmelons

In all cases the pack should be snug and the package so full that it will have a slight bulge, to allow for shrinkage in transit. Melons that are slack packed will shift about during handling, become bruised, and invariably sell at a discount when they reach the market. As rapidly as the crates are packed they should be loaded into refrigerator cars or upon a wagon or truck and sent to market in the shortest possible time. When the packing is done under field shelters the melons should be protected from the sun at all times and especially after they are graded and packed in the shipping crates.

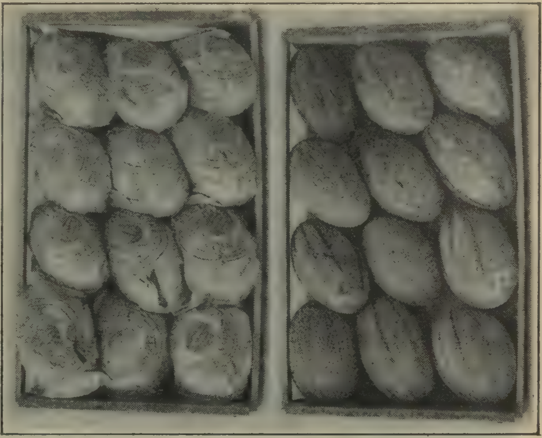

FIG. 31.—Burrell Gem muskmelons packed in flat crate, wrapped and unwrapped

Wrapping individual muskmelons in tissue paper before packing them in the crates for shipment gives the package an attractive appearance but is not advisable, as the paper interferes with the

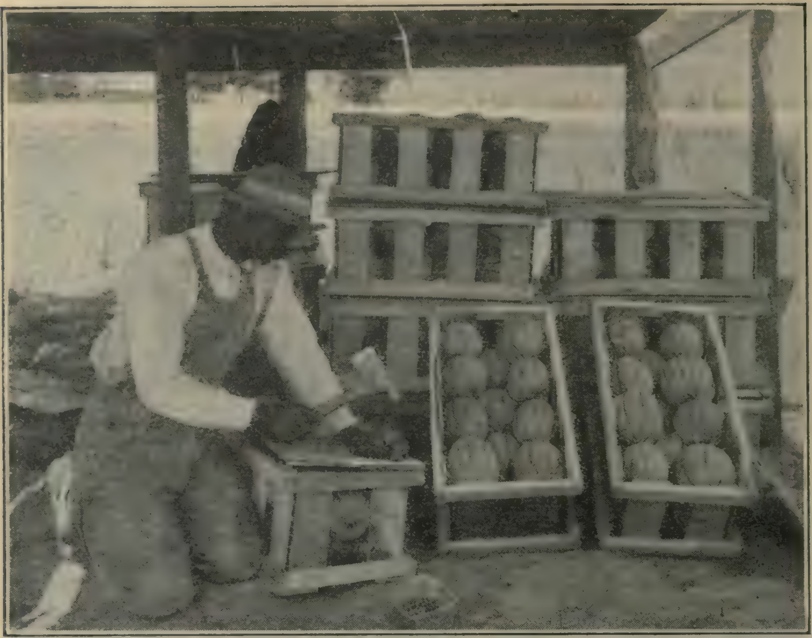

Fig. 32.—Crates used by growers in the Norfolk (Va.) section for shipping muskmelons

cooling of the melons in the refrigerator car and often causes them to mold in transit. Melons that are well netted, clean and smooth, and packed in neat attractive crates present the best possible appearance on the markets. The use of well-designed colored labels on the ends of the crates adds materially to the appearance of the package, but the color work on these labels should not be overdone and the

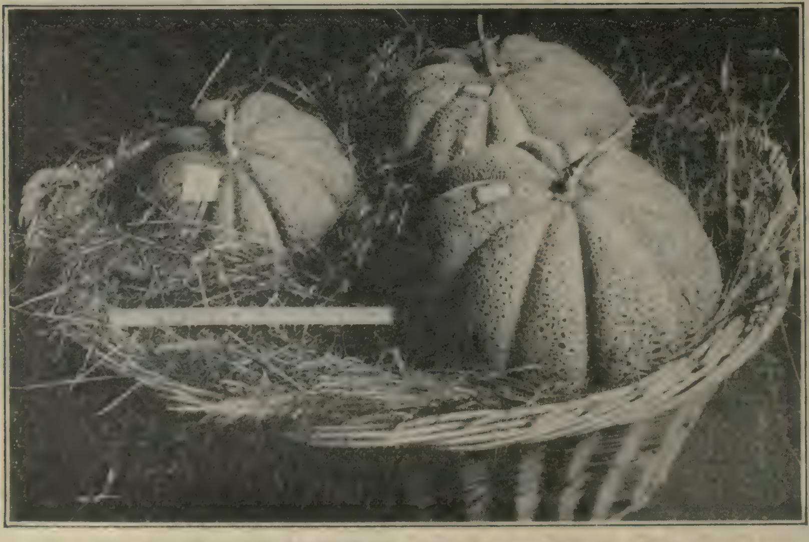

Fig. 33.—Montreal muskmelons packed in special willow baskets

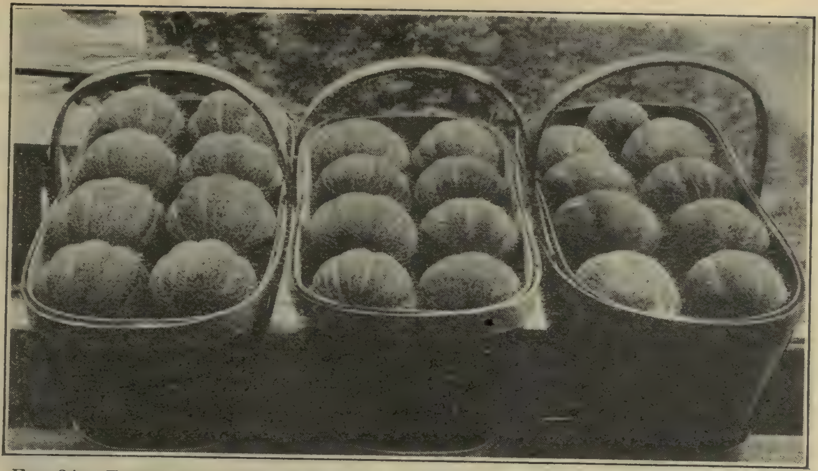

FIG. 34.—Twelve-quart Climax baskets occasionally used in the Eastern States for marketing muskmelons locally

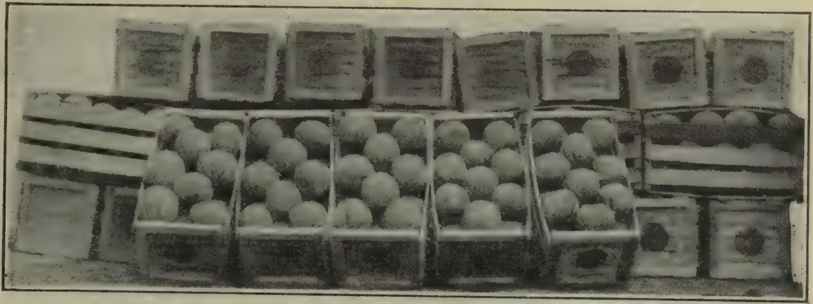

FIG. 35.—Miscellaneous or jumbo packs of muskmelons

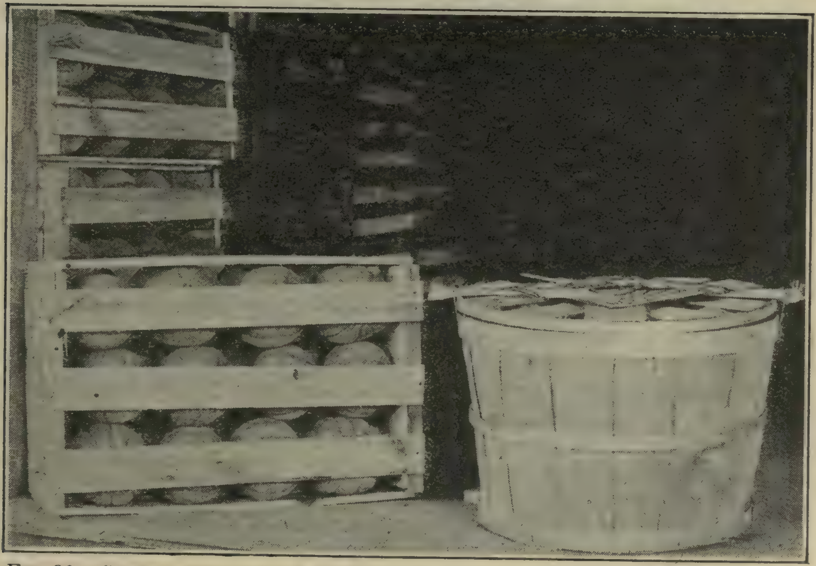

FIG. 36.—Special crate and bushel basket used for shipping muskmelons in eastern Maryland

label should not misrepresent the contents of the crate as to variety, grade, or the locality where grown. In a few shipping sections it is the practice to place a small sticker of paper upon each melon. This is good advertising but involves considerable extra labor: besides, every time the individual melons are handled, the liability to injury is increased. Rough handling must be avoided all along the line and especially after the melons are packed in the crates.

SELLING MUSKMELONS AT ROADSIDE AND LOCAL MARKETS

The development of motor transportation and the increase in automobile travel have created a splendid opportunity for the local production and sale of muskmelons. By means of truck transportation markets 40 to 60 miles from the point where grown can be supplied with vine-ripened melons of high quality. Roadside markets, if properly conducted, soon gain a patronage that will take care of a considerable acreage of melons and are often established temporarily on main-traveled highways for the sole purpose of handling a melon crop. Where these markets are more or less permanent and handle other farm products the melons can be made special during their season. One melon grower, whose roadside market is shown in Figure 37, follows the practice of leasing suitable acreage, usually bluegrass or clover sod, located within a mile of a central point on the main highway, where his market is established during the period that the melons are to be sold. The plan followed by this grower is to plant only on land that has not been in melons for a number of years, to spray regularly, and to produce high-class melons. Two small motor trucks are used for hauling the melons from the fields to the market, where they are graded and displayed in bins that face the roadway. In addition to the sales that this grower makes to the many automobilists that pass, his best customers drive from the city primarily to obtain a supply of melons of fine quality, and they usually buy in considerable quantity, including those that are fully ripe and some that will keep for three or four days. No packages are required for the sale of the melons, as the customers usually bring baskets with them. A few bushel baskets and hampers are

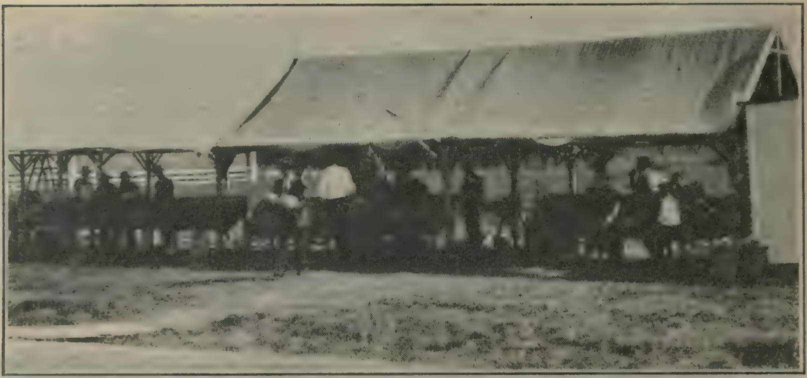

FIG. 37.—Temporary roadside market used exclusively for selling muskmelons grown in near-by fields

kept on hand and are sold to any customers who desire them. The melons as displayed upon the tables (fig. 38) are graded according to size and freedom from defect, a difference of 5 cents being usually made between the grades. The prices during the height of the season as a rule range from 15 to 30 cents each and are considered very reasonable for melons of the size offered.

In Indiana, Ohio, and other of the North-Central States great quantities of muskmelons of the Tiptop and Ohio Sugar varieties are sold from trucks and wagons on the curb markets. These melons are frequently very large, are of excellent flavor, and find a ready sale.

FACTORS GOVERNING THE COST OF GROWING AND HANDLING

Cost accounts covering the growing and handling of a crop of muskmelons necessarily vary for the different producing sections and are dependent upon the character of the season. Occasionally an individual grower or an association of growers has kept cost accounts, but comparatively few of these are available. Under the circumstances, it is deemed advisable in a publication of this character to give only figures that have been obtained by the Department of Agriculture and to list the items that would naturally be included in calculating the cost of growing a crop.

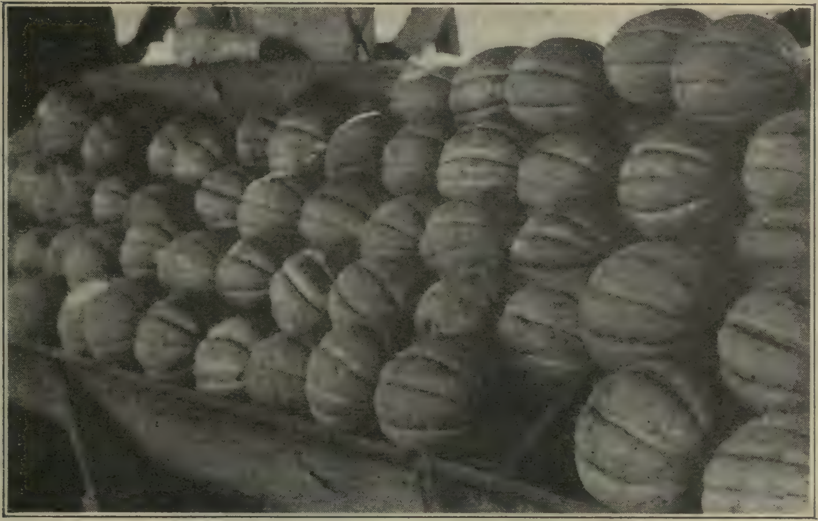

FIG. 38.—Muskmelons displayed at a roadside market

The items entering into the cost of growing melons are listed under three heads, as follows:

(1) Overhead expense, including rental of land. In case the grower owns the land, the rental should be offset by a reasonable interest on his investment and the taxes, computed on the basis of rental for similar land in the immediate neighborhood. To these charges should be added a certain percentage for depreciation on equipment used exclusively or in part for producing and handling the crop.

(2) Under crop production should be included all labor connected with fitting the land and growing the crop, manure, commercial fertilizers, seed, poison, and other materials used for spraying or dusting, water for irrigation, and all other expenses involved. Under this head also should be included

the cost of gathering the melons in the field, hauling to the packing shed or to the local market, and depreciation on field crates or baskets used in the field.

(3) Under marketing should be included the cost of shipping packages, grading, packing, and delivery to the shipping point or to the local market. To this should be added commissions and sales charges and all other expenses of marketing.

YIELDS AND RETURNS PER ACRE

According to figures obtained by the Bureau of Agricultural Economics of the United States Department of Agriculture in 1919, the average acre yield of muskmelons in the Brawley, Calif., district was 161½ standard and 28½ pony crates—190 crates in all. In 1920 the average yield was about 145 crates per acre. Yields of about 200 standard crates are not exceptional, but those of 135 to 145 standard crates are more common.

In 1915 an estimate was made in the Brawley district of the cost of growing and loading a standard crate of muskmelons on the cars, and the resultant figure was 70 cents. In 1919 the costs were again checked, and the estimates ran from $1 to $1.50 per standard crate, averaging $1.15. Land rents in 1919 were $30 to $50 per acre. In 1920 the average cost per crate delivered at the loading sheds was $1.50, land rents being $35 to $60 per acre.

In sections where the largest types of muskmelons, such as Tiptop, Ohio Sugar, Surprise, Early Hackensack, and Montreal Market, are grown a smaller number of individual melons are produced, but the total on the basis of standard crates is about the same. According to census figures, in 1919 the average farm value of muskmelons was $137 per acre. The proportion of the total that may be figured as net returns varies greatly, but at best the net proceeds from a crop of muskmelons is not great. Small acreages near a good local market or where the melons are retailed at a roadside market give the highest returns per acre.

SUMMARY

Muskmelons can be grown for the market throughout a wide range of territory, the main requirements for their culture being a well-drained or rather light but fertile soil and a fairly long growing season, with plenty of sunshine, especially during the ripening period.

Insects and diseases must be controlled, especially the striped cucumber beetle and the leaf diseases commonly known as blight.

Good seed, the judicious use of fertilizers, clean, shallow cultivation, and care in irrigation where it is practiced are important factors in the production of a crop of muskmelons.

Muskmelons must be reasonably ripened on vigorous disease-free vines in order to attain sweetness and a desirable flavor. Exceptions to this are found in the Casaba, Honeydew, and certain of the so-called winter muskmelons, which may be ripened in storage. These, however, must be full grown and have stored in them the necessary starch and other ingredients before their removal from the vine.

Melons require careful handling to prevent bruising or any injury which will cause decay.

The large markets are now well supplied with muskmelons of medium to fair quality, but there is a splendid opportunity for the development of local markets within easy truck haul and for the sale of muskmelons of good quality at roadside markets.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1926

Ind

U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1469

LAWS RELATING TO FUR ANIMALS FOR THE SEASON 1925-26

1862 1889

THE information contained in this bulletin, the eleventh annual publication on the subject, should be useful in promoting effective action on the part of trappers, members of the fur trade, and all others concerned to the important end of perpetuating one of the most valuable of our natural resources. Too large a proportion of the pelts coming to the raw-fur markets fall into the unprofitable class because they were taken when not prime, a waste which can be eliminated by cooperation between the fur trade and the trappers. The average quality of pelts would be much higher if laws made seasons shorter and uniform for areas having the same climatic conditions. If the fur business is to maintain its position among the great industries of the country the continued source of supply must be assured. The trappers and the furriers, as trustees, are jointly responsible for the permanence of our fur resources. The board of trade of the fur industry of the United States estimates the annual turnover in the fur business at $400,000,000.

Washington, D. C. **September, 1925**

LAWS RELATING TO FUR ANIMALS FOR THE SEASON 1925-26

By Frank G. Ashbrook, *in Charge, Division of Fur Resources*, and Frank L. Earnshaw, *Assistant, Interstate Commerce in Game, Division of Migratory-Bird Treaty and Lacey Acts, Bureau of Biological Survey*

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FUR CONSERVATION ESSENTIAL

THE perpetuation of fur-bearing animals in the wild is as much a matter for public concern as the conservation of any other natural resource. Although administration of forests, fish, and game may rest with either individual States or the Federal Government, the maintenance of the fur supply is primarily the business of the States. The United States Department of Agriculture is charged with the enforcement of the Federal Lacey Act, a law which regulates interstate commerce in wild animals and supplements State legislation in efforts for the conservation of fur animals. In administering the law the attitude of the department is one of cooperation and coordination and not of Federal control.

CAUSES OF FUR DEPLETION

The value of the annual catch of fur-bearing animals in the United States 25 years ago was roughly estimated at $25,000,000. To-day it is estimated at $70,000,000. If the supply of fur animals had been maintained in suitable areas, the income to trappers would have greatly exceeded present-day values. Much of the actual loss on furs taken could be eliminated by confining trapping to periods of prime fur and exercising care to remove pelts properly and to cure them thoroughly before shipment to raw-fur receiving houses.

Trapping too early or too late and failing to care for furs properly have resulted in a loss of approximately 20 per cent of the annual catch. Receiving houses are responsible for much of this waste by sending out early price lists containing quotations on prime furs not obtainable at the time—a formal invitation to the trapper to begin operations at once. By such action not only does the receiving house accept unprime pelts but the trapper gets a smaller return than he would have received by starting operations during the season of prime fur. All fur bearers increase rapidly under reasonable protection, and if the unprime animals now killed every year were left for breeding stock this probably would not decrease the annual catch more than 5 per cent, and within five years the supply of wild fur animals would without doubt be increased 50 per cent.

That many trappers have been permitted to ply their trade out of season and to gather pelts to the point of extermination of the fur bearers over large areas is only one cause for our present shortage. Serious responsibility rests also on fur buyers and their agents who, by accepting at a price all skins offered, thus marketing illegal pelts, tempt trappers to make a thorough clean-up all along their trap lines. Another factor in the scarcity of fur animals is found in the greatly reduced fur-producing areas. The encroachment of civilization naturally reduces the extent of such areas, but more thought and attention can well be given to the indiscriminate drainage of swamps and to the unnecessary cutting and destroying of forests and cover.

Taking an unprime pelt is a deliberate waste of one of nature's most valuable and beautiful gifts, and not until trappers and raw-fur men learn to look upon it as such will the best use of our valuable resources in fur be realized.

OPEN SEASONS

Ill-advised open seasons are a natural result of lack of sufficient information regarding the life habits of fur animals on the part of farmers, trappers, members of the fur trade, legislative committees, and even of conservationists. The seasons established by a number of States do little to prevent the decrease of fur bearers in certain sections. A defect frequently noted in present fur laws is that the open season provided is so long that it permits trapping before pelts are prime in fall and after breeding is in progress in spring.

Fur is in prime condition for harvesting at one brief season only. An open season of more than three months' duration is not justifiable anywhere in the United States if the prime condition of peltries and the economic status of fur animals were taken into consideration. That the seasons are not wisely determined is emphasized by the fact that far too many unprofitable pelts are coming to the raw-fur markets every year. A keener appreciation of conditions revealed by studies of the habits, breeding seasons, and periods of prime fur on the part of those concerned with the framing of laws and regulations governing trapping would result in increased pelts of superior quality reaching the markets, thus allowing greater financial rewards to trappers and at the same time augmenting the numbers of breeders in the covers.

A few generations ago furs of many kinds were commonly taken in all sections of the country, but now, with the depletion or extinction over great areas of certain of the more prized species, the most valuable fur bearers, from the viewpoint of financial returns from the annual catch, are muskrats, skunks, raccoons, and opossums.

REPORT OF TRAPPERS

The only satisfactory method of determining the number of skins taken annually is to obtain a count before the pelts enter the trade. This can be done by requiring the trappers to turn in an annual report of the number of each species taken. Several States already have such a provision in their fur laws, but not until every State has adopted some system of recording the annual catch will it be possible to estimate the number of fur bearers taken annually in the United States.

The following tabulation from the report of the State game and fish commissioner of Minnesota furnishes an example of the data obtainable by requiring licensed trappers to make annual reports of the number of fur animals taken:

Fur-bearing animals taken in Minnesota under trapping license

Kind	1920–21	1921–22	1922–23	1923–24
Mink	18, 248	37, 750	18, 132	21, 217
Muskrat	120, 934	273, 675	117, 801	144, 769
Weasel	32. 019	63, 770	30, 141	42, 977
Skunk	22, 101	40, 715	24, 071	26, 969
Raccoon	2, 210	4, 180	2, 768	1, 757
Squirrel	5, 724	10, 381	40, 001	5, 992
Rabbit	16, 208	38, 828	37, 751	17, 137
Wolf	895	2, 696	917	2. 134
Red fox		849		
Cross fox		94	47	39
Gray fox		67	103	82
Badger	312	404	283	527
Civet cat	45	199	258	183
Bobcat	74	229	173	94
Lynx	73	310	239	147
Fisher	215	242	125	140
Bear	68	87	92	48
Marten	49	68	28	41
Miscellaneous	510		125	
Totals	219, 685	474. 544	273, 055	264, 253

The license-report system would provide not only a basis for an estimate of the total number and value of furs taken annually but also the best-known means for the registration and identification of trappers, for the renewal of licenses from year to year would be dependent upon the filing of satisfactory returns on the previous season's catch.

PROPAGATING FUR ANIMALS IN CAPTIVITY

Fur farming in the United States and Alaska is steadily developing, and certain phases are becoming a permanent addition to agricultural production. It may often be conducted profitably on land of little or no value for crop growing. For the year 1924 there were approximately 2,000 fur farmers in the United States and Alaska engaged in the production of one or more species of fur-bearing animals, the majority of them raising silver and blue foxes. The total investment in the business is somewhere between $15,000,000 and $18,000,000. More than 1,200 fur farms were in operation in Canada in 1923, and the total investment amounted to more than $8,000,000.

Fur farming in Europe has had a steady although a very quiet growth, and during the past year has provided an outlet for products of American ranches. Numerous shipments of silver, cross, and red foxes, skunks, raccoons, and minks have been made to Norway, Sweden, Scotland, England, France, and Switzerland. Fox ranches have been in operation for several years in Norway and Scotland and in wilder parts of Northumberland and Yorkshire, England.

Fur farming occupies a place in the general scheme of conservation, and the extent to which the industry may develop depends not only on the interest manifest by the breeders but also on the support and encouragement given the industry by legislation. The business is no longer an experimental enterprise, and deserves more careful attention on the part of those framing laws relating to the propagation of fur bearers. The production of these animals in captivity should be encouraged rather than discouraged.

In 8 of the 34 States in which fur farming is being carried on there is no legislation on the propagation of fur bearers except to prohibit taking or killing during the close season. The majority of States, however, require permits for fur farming, for which a fee of $1 to $25 is charged. Persons lawfully acquiring fur-bearing animals should be given the legal right to possess them during close season. The fur-farming industry should be as little hampered by legislation as possible consistent with affording adequate protection to fur animals in the wild. Although a permit should be required for capturing and keeping fur-bearing animals, the charge therefor should be nominal. A fur farmer should also be required to make an annual report of the number of animals pelted, so that farm-raised furs may be included with the furs reported taken by trappers.

The Biological Survey maintains an experimental fur farm near Saratoga Springs, N. Y., and by investigations of diseases and parasites of fur animals and of management under controlled conditions seeks to give aid in some of the fundamentals of fur farming.

INTERSTATE SHIPMENTS OF PELTS

The United States Department of Agriculture, through the Biological Survey, is in position to aid State authorities in the prosecution of many violators of State conservation laws through the provisions of the Federal Lacey Act, which governs interstate shipments of wild animals. This legislation, enacted May 25, 1900, and amended and incorporated in the Criminal Code of the United States on March 4, 1909, prohibits delivery to any common carrier for transportation from one State to another of the dead bodies or parts thereof of wild animals, where such animals have been killed or shipped in violation of the laws of the State in which killed or from which shipped. It stands continually on guard as a supplement to State legislation for the protection of wild animals, and deserves careful study by all concerned in revising and framing State laws relating to fur animals, if the States are fully to avail themselves of its provisions. While this law carries no police power, and while the Federal wardens employed in its enforcement are not empowered to seize illegal shipments of furs or game animals, the department and the Federal wardens under its jurisdiction maintain close cooperation with the various States, and many thousands of dollars in penalties annually accrue to the States through the activities of Federal agencies operating under this law.

A violation of the Lacey Act is predicated upon a violation of the State law, but owing to the present status of State laws it is seldom possible to institute Federal prosecutions for illegal shipments of furs. The actual evidence of the illegal killing of fur animals is most difficult for the department to obtain as compared with the documentary evidence of shipments. For instance, frequently a State will protect beavers for an indefinite term or for a period of years, but will make no provision concerning the possession, sale, and shipment from the State of skins of such animals during the continuance of the close season.

In the enforcement of the provisions of the Lacey Act it has been found that most reputable raw-fur houses are eager to cooperate to the fullest extent in the suppression of traffic in unprime and contraband skins. The outstanding need in connection with traffic in beaver skins is for a system of branding, perforating, or permanently marking those legally taken so that they may be satisfactorily identified and traced to the point of origin. With some such fairly uniform system in vogue in the beaver-producing States, reputable raw-fur dealers would be in position to refuse to handle contraband skins.

The system of tags, affidavits, and shipping permits in connection with the payment of royalties on furs in the various Provinces of Canada, appears to work to advantage in the suppression of illegal traffic in the skins of fur-bearing animals. Upon the payment of the royalty a duplicate form of tag is attached to the skin; half of it is surrendered for an export permit, while the stub remains attached to the skin as evidence that the royalty has been paid.

REVIEW OF LEGISLATION OF 1925

THE ALASKA GAME LAW

The most important law relating to wild life that was passed during the last session of the Sixty-eighth Congress was the Alaska game law, which authorized the appointment of a game commission for the Territory and broadened the the administrative and enforcement provisions on behalf of the United States Department of Agriculture. Under the new law the department has promulgated regulations recommended by the Alaska Game Commission on game, birds, and land fur-bearing animals designed to afford better protection to the wild life under its jurisdiction.

The commission under the new law is composed of five members, four of whom are resident citizens of the Territory and of the judicial division from which appointed. The fifth member, a representative of the Biological Survey, is the executive officer of the commission. Wardens are maintained in the Territory within the limits of appropriations. Coordination in the administration and enforcement of the law relating to game and land fur-bearing animals should promote the conservation of these natural resources of the Territory.

The law prescribes licenses for nonresident trappers and for fur dealers, and under its provisions the commission has by regulation required resident-trapping licenses to take land fur animals, and trappers and dealers are required to make annual reports of their operations. The seasons prescribed under the regulations are designed to afford adequate protection to fur animals and, at the same time, to allow trapping during the seasons calculated to produce the maximum return on the furs taken. Certain destructive methods of taking fur animals are prohibited, including the use of shotguns, artificial lights, steel bear traps and traps having a spread of jaws exceeding 9 inches, poisons, and dogs, as well as digging out or destroying homes or dens, or driving animals from their dens by the use of smoke or chemicals. Fur farming is encouraged by provision for the taking of fur animals for propagating purposes under permits from the Secretary of Agriculture.

OTHER LAWS

Changes in regard to fur animals have been made in all States except Kentucky, Maryland, Mississippi, and Virginia since Farmers' Bulletin 1445 on the laws relating to fur animals for the season 1924–25 was issued. Practically new fur laws were enacted in Texas, West Virginia, and Wyoming, and substantial revisions were made in Idaho, Louisiana, Michigan, Minnesota, Montana, South Dakota, Utah, and Wisconsin.

Protection was afforded raccoons and opossums in Arkansas and South Dakota; raccoons and foxes in Vermont; raccoons, opossums, muskrats, beavers, and otters in West Virginia; otters, fishers, martens, minks, muskrats, raccoons, and foxes in Wyoming; and skunks, raccoons, and foxes in Prince Edward Island.

Trapping was suspended on muskrats until 1928 in Iowa; on beavers, otters, and fishers until 1930, and on minks and muskrats until 1927 in Michigan; on raccoons and muskrats for an indefinite period in Minnesota; on martens until opened by the commission in Montana; on beavers in parts of Oregon; on muskrats in South Dakota east of the Missouri River until 1927; and on otters, martens, minks, muskrats, skunks, and raccoons until 1927 in Prince Edward Island.

Seasons previously closed were opened to trapping on martens, fishers, and foxes in Idaho; on martens, minks, and muskrats in Utah; and on otters in nine counties in Wisconsin.

SUMMARY OF LAWS

Legislation for the protection of fur animals has not progressed in some States to the stage of stringent regulation, and this condition, together with the fact that such legislation is in the formative period, makes it often exceedingly difficult to determine what restrictions apply to transporting and marketing furs.

In stating the open season the plan has been followed, as in the bulletin on the game laws,[1] to include *the first and last days thereof*. Statements regarding trapping on lands of another do not take into consideration the general trespass laws of the State. The bounty laws included relate for convenience to all animals and birds on which bounty is paid

FEDERAL LAWS

Two Federal laws have a bearing on the fur industry of the United States—the Lacey Act, governing interstate commerce in wild animals, and the tariff act of September 21, 1922.

That part of the Lacey Act codified as section 242 of the Criminal Code (35 Stat., 1137) makes it unlawful to deliver to a common carrier for transportation "from any State, Territory, or District of the United States to any other State, Territory, or District thereof" the bodies or parts of bodies of any wild animals killed or shipped in violation of the law of the State, Territory, or District in which killed or from which shipped.

The tariff act of September 21, 1922, places a duty of 15 per cent ad valorem on all live wild animals shipped into the United States. This includes silver and black foxes, the skins of which, dressed or undressed, and manufactures thereof, are dutiable at 50 per cent ad valorem. Other furs dressed on the skin, not advanced further than dyeing, are dutiable at 25 per cent ad valorem. Raw furs and skins (except silver and black fox skins) are admitted free.

The regulations of the Department of Agriculture for the inspection, quarantine, and entry of foxes have been rescinded. Foxes may now be brought in at any port on presentation of the regular importation permits and payment of the duty imposed by the tariff act.

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[1] Laws relating to game animals, including deer and other big game, rabbits, and squirrels, will be found in Farmers' Bulletin No. 1466, "Game Laws for the Season 1925–26.

LAWS OF STATES

ALABAMA

Open seasons:[1]

	Dates inclusive
Beaver, otter, bear, raccoon, fox, opossum, mink, muskrat (trapping)	Nov. 1–Feb. 28.[2]

Prohibited methods: Unlawful to set traps in such manner as to endanger domestic stock.

Licenses: Fee, $15 for first trap and $2.50 for each additional trap; issued by probate judges. Landowners or landlords, tenants, and members of families may trap on own land during open season without license. Written permission required to trap on land of another.

Possession and sale: Possession of the young of protected fur animals prohibited during close season. No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: Under special permit from commissioner of game and fisheries fur animals may be captured or possessed for propagation.

Bounties: None paid.

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[1] *Alabama:* Owner may protect premises in any manner at any time from depredations of fur animals.

[2] Fur animals may be hunted with dog or gun: Sept. 1–Feb. 28.

ALASKA[1]

Open seasons:[2]

	Dates inclusive
District 1:[3 4]	
Muskrat	Dec. 16–Apr. 30.
Land otter, mink, weasel (ermine)	Dec. 16–Mar. 31.[4]
Red, cross, and silver foxes, lynx	Dec. 1–Feb. 15.
Blue fox (on Aleutian Islands Reservation only)	Dec. 1–Feb. 15.
Black bear (including its brown and blue—or glacier bear—color variations)	Sept. 1–June 15.
Wolf, coyote, wolverene, marmot	No close season.
District 2:[5]	
Muskrat (see exception)	Mar. 15–May 31.
Exception: South summit Alaska Range and Ahklun Mountains	Dec. 16–Apr. 30.
Land otter, mink, weasel (ermine)	Nov. 16–Mar. 31.
Foxes (blue foxes, north summit Alaska Range and Ahklun Mountains only—south, no open season), lynx	Dec. 1–Mar. 31.
Black bear (including its brown and blue—or glacier bear—color variations)	Sept. 1–June 15.
Polar bear, wolf, coyote, wolverene, marmot	No close season.
District 3:[6]	
Muskrat	May 1–June 10.
Mink, land otter, weasel (ermine), fox, lynx	Nov. 16–Mar. 31.
Black bear (including its brown and blue—or glacier bear—color variations), polar bear, wolf, coyote, wolverene, marmot	No close season.
Throughout Territory:	
Beaver, marten, sea otter	No open season.
Bear (large brown and grizzly)	No close season.

Prohibited methods: Unlawful to take or kill land fur animals with poison (except that under permit poison may be used by game warden or predatory-animal hunter for wolves, coyotes, and wolverenes), by use of trap or device known as the "klips," steel bear trap, or any other trap with jaws having a spread exceeding 9 inches, by aid or use of a shotgun, fire, jacklight, pit lamp, searchlight, or other artificial light, or (except polar bear) by aid of a dog. No fur animal may be taken from its home or den, by digging, smoking, or the use of chemicals, and no home, house, den, or runway of a beaver or muskrat may be injured or destroyed.

ALASKA—Continued

Bag limits: Three large brown and grizzly bears a season.

Licenses: *Trapping:* Nonresident, $50 (nonresident, hunting large brown or grizzly bears, must have registered guide); resident, $2 (not required of residents under 16 years of age, nor of native-born Indians, Eskimos, or half-breeds who have not exercised the right of franchise or severed their tribal relations). Alien, $100 (special license, issued by members of commission). *Fur dealer:* Resident, $10. Nonresident citizen, or corporation, association, or copartnership organized under laws of Territory, or a State of the United States, $250. Alien, or a corporation, association, or copartnership not organized under the laws of Territory, or a State of the United States, $500 (agents, nonresident citizen, $250; resident, $10). Licenses issued by members of commission, game wardens, and authorized agents. Dealer's license not required of native-born resident Indian, Eskimo, or half-breed who has not exercised the right of franchise or severed his tribal relations, or of a hunter or trapper to sell skins of fur animals he has lawfully taken, and a person not engaged or employed in the fur trade may buy furs for his own use, but not for sale.

Licensees, within 30 days after expiration of license, must report to game commission, Juneau, number and kind of fur animals taken, purchased, or otherwise procured under license. Fur dealer must also comply with Territorial laws.

Territorial licenses and requirements: Stationary fur buyer, $15; traveling agent for stationary fur buyer, $15; traveling fur buyer, $100; issued by United States commissioner; fur buyer must also pay license tax on each pelt, as follows: Sea otter, $3; silver fox, $2; black fox, $2.50; blue fox, 75 cents; polar, brown, and grizzly bear, and cross fox, 50 cents; black bear, beaver, marten, land otter, red and white fox, lynx, 25 cents; muskrat, weasel, 2 cents; pelt not specifically mentioned, 10 cents. No Territorial license required for trapping, but trapper sending or removing furs from Territory must pay license tax on such skins and must keep record of all pelts taken and make annual report to United States commissioner on or before August 1, showing to whom and when sold or disposed of; and must pay tax on all pelts not sold to licensed fur trader in Territory.

Possession and sale: No restrictions on prime skins legally taken. Fur dealers required to be licensed (see "Licenses"). Unlawful to sell the hides, heads, or horns of any game animals (includes large brown and grizzly bears), except the hides or parts thereof of moose, caribou, deer, and mountain goats legally taken during open season, and shed antlers of caribou, moose, and deer. Blue-fox skins must be tagged or branded before being sold.

Shipment and export: No restrictions on prime skins legally taken, but no person who is engaged in fur farming or the fur trade as a dealer or agent shall possess or transport such furs without a license. Skins of beaver and marten legally taken may be possessed and transported by any person until November 1, 1925. Territorial license taxes must be paid before shipment, and blue-fox skins (other than those raised on farms having a registered brand and branded with such brand), whether acquired in Territory or imported, must be tagged (fee, $1.50) by United States commissioner.

Shipment must be accompanied by statement showing number and kind of skins therein and that no unprime skin is included, such statements to be taken up and mailed to Alaska Game Commission, Juneau, by collectors of customs when by freight or express, by postmasters, when by parcel post, or direct to commission by shipper when by other means.

Nonresident citizen or alien may export three large brown or grizzly bears under hunting license coupons and affidavit of lawful killing.

ALASKA—Continued

Resident may export for mounting and return within one year, two heads or trophies of large brown or grizzly bears legally killed, under permit and bond, fee $1, and bond $50, for each trophy. Resident citizen removing from Territory may export large brown or grizzly bears legally acquired, under permit and bond, fee $5, and bond $50, for each specimen. (See "Licenses.")

Propagation:[7] License, fee $2, must be obtained from Alaska Game Commission, to conduct a fur farm or to possess fur animals for propagation. Fur animals may be taken for propagation under permit from the Secretary of Agriculture and countersigned by the executive officer of the commission. On the Aleutian Islands Reservation and certain other islands, permits to use the islands for fur farming and to trap animals for breeding purposes must be obtained from the Department of Agriculture. Fur farmer must obtain Territorial license, fee $10, and pay Territorial license tax on each pelt sold. Issued by commissioner. Blue-fox farmer must register brand, fee $10.

Bounties: Wolf, $15; eagle, $1 (paid by Territory).

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[1] *Alaska:* Regulations under the Alaska game law of January 13, 1925, relating to land fur animals may be obtained upon application to the Secretary of Agriculture, Washington, D. C., or to the executive officer, Alaska Game Commission, Juneau, Alaska. For special information regarding sea otters and fur-seal fisheries and the Afognak Reservation, which are subject to special legislative and administrative control, application should be made to the Commissioner of Fisheries, Washington, D. C.

[2] Unlawful to kill land fur animals when the fur is unprime; the killing of all land fur animals in Mount McKinley National Park, Katmai and Glacier Bay National Monuments, on Kruzof and Partofshikof Islands and in drainage of Taku River from Taku Point to east end of face of Taku Glacier is prohibited.

[3] District 1 includes the Aleutian Islands, Alaska Peninsula, and neighboring islands, and southeastern Alaska, mainland and islands, from Yakutat Bay to Dixon Entrance.

[4] Land otter, weasel (ermine), on Kodiak-Afognak Islands Group—Dark Island on the north, Marmot Island on the east, and Tugidak and Trinity Islands on the west and south—December 1-February 15.

[5] District 2 includes the mainland and islands from Yakutat Bay, Gulf of Alaska, Iliamna Lake, and Bristol Bay, northward to the headwaters of the streams flowing into the Arctic Ocean north of the sixty-eighth parallel of north latitude.

[6] District 3 includes the region drained by the streams entering the Arctic Ocean north of the sixty-eighth parallel of north latitude.

[7] Unlawful to feed to a fox or other fur animal held in captivity, any part of a game animal or bird other than an eagle, a raven, crow, hawk, owl, or cormorant, except waste parts such as hides, viscera, and bones.

ARIZONA

Open seasons:

Fur and predatory animals.... No close season.[1]

Prohibited methods: No restrictions.

Licenses: Fee, $2.50; issued by warden, designated deputies, and clerks of boards of supervisors. License not required for trapping on own land, nor by persons under 18 years of age. Unlawful to disturb or remove traps of licensed trappers on public domain or on lands where they have permission to trap.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Miscellaneous: Unlawful to use fish or the flesh of any game bird or animal for trap bait.

Propagation: Under permit from State game warden, fur-bearing and predatory animals may be kept for propagation, exhibition, or sale.

ARIZONA—Continued

Bounties: Payment of bounties is optional with county boards of supervisors.

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[1] *Arizona:* Mountain lion, wolf, fox, coyote, lynx, wildcat, skunk, or other obnoxious animals may be taken on State game preserves only under regulations of the State game warden. Owner may protect his premises from the depredations of predatory and fur animals at any time.

ARKANSAS

Open seasons:[1]	*Dates inclusive*
Bear, beaver, otter (see exceptions)	Dec. 1, 1928.
Exceptions: Bear (15 days), Nov. 15-19, Dec. 26-30, and Jan. 10-14, inclusive, and beaver and otter, Nov. 15-Jan. 31, in Chicot and Desha Counties.[2]	
Racoon, opossum	Nov. 15-Feb. 1.
Other fur animals (see exception)	Dec. 1-Jan. 31.
Exception: In Chicot and Desha Counties[2]	Nov. 15-Jan. 31.
In Clay County	Oct. 1-Mar. 1.

Prohibited methods: No restrictions.

Bag limits: One bear a season.

Licenses: Trapping license, $20 (only required for use of 12 or more traps). Hunting license required to kill bears: Resident, $1.10; nonresident, $15; dog, used in hunting bears, $1.50; issued by State game and fish commission and circuit clerks.

County licenses for bear: Chicot County: Nonresident of State, $50; resident of State, $5.25; *Desha County:* Nonresident of State, $50; resident of State, $2.50. Issued by circuit clerks. Licenses not required of residents under 16.

Possession and sale: Sale or possession of pelt taken in State prohibited except between December 1 and February 5. Sale or exchange of bears prohibited.

Shipment and export: No restrictions except on bears, the export of which is prohibited except by nonresident licensee under affidavit that the bear was legally taken and is not for sale.

Propagation: The fish and game commission is authorized to issue permits to breeders of game and fur animals under such regulations as it may prescribe.

Bounties: County courts may offer bounty on wolf, wildcat, or panther, and fix the amount of such bounty.

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[1] *Arkansas:* Fur animals found destroying crops or poultry may be killed at any time.

[2] In Chicot and Desha Counties fur animals may only be taken on own or leased land or land adjacent to cultivated crops.

CALIFORNIA

Open seasons:[1]	*Dates inclusive*
Black or brown bear, ring-tail cat, coon, pine marten, fisher, wolverene, mink, skunk, river otter, fox	Oct. 15-Feb. 28.
Seal and sea lion (in Game District 19, no open season)	Unprotected.
Beaver[2] (see exception), sea otter	No open season.
Exception: Beaver in fish and game districts[3] 1, 2, and 3	No close season.

Prohibited methods: Unlawful to use poisons or gun larger than No. 10 gauge in taking fur animals, or to dig or smoke out skunks from dens.

Licenses: [1] Citizen, $1; alien, $2; issued by fish and game commission. License issued free to veterans of Civil War. Duplicate license issued only on affidavit of applicant that original has been lost or destroyed. License not required of persons under 18 years of age. Licensed trappers required to report catch before July 1. Licensee

CALIFORNIA—Continued

must exhibit license and furs to wardens or peace officers upon demand. Unlawful to disturb or remove traps of licensed trapper who is trapping on the public domain or on lands where he has permission to trap.

Possession and sale: Unlawful to possess green beaver hides except in fish and game districts [3] 1, 2, and 3. No restrictions.

Shipment and export: No restrictions.

Propagation: Fur animals may be raised in captivity under regulations of the commissioners.

Bounties: Mountain lion, female, $30; male, $20; paid by fish and game commission. Boards of supervisors of counties may fix the rate and pay bounty on coyote, wildcat, fox, lynx, bear, or mountain lion. Many counties now pay a bounty on some of these animals, especially on coyotes.[4]

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[1] *California:* Written permission from board of fish and game commissioners required to trap or hunt predatory animals on State game refuges.

[2] Beaver doing damage to levees or other protective works in reclamation, levee, or swamp-land districts may be taken under permit from commission, such taking to be reported within 10 days, when commission issues permit for disposition of skins.

[3] District 1 comprises the northern part of the State, the Sierras, and the eastern half of the Sacramento and San Joaquin Valleys, including all counties not included in districts 1½, 1¾, 2, 2½, 3, 4, 4½, and 4¾.

District 1½ comprises the counties of Del Norte, Siskiyou, and Humboldt.

District 1¾ comprises Modoc and Lassen Counties.

District 2 comprises that part of the State south of Humboldt and Tehama Counties, west of the Sacramento River and north of San Francisco Bay, including the counties of Glenn, Colusa, Yolo, Solano, Napa, Lake Sonoma, and Marin, and that portion of Mendocino County not included in district 2½.

District 2½ comprises that portion of Mendocino County lying west of divide between Eel and Russian River systems and Pacific Ocean and not included in District 7.

District 3 comprises the region around the southern portion of San Francisco Bay and the coast counties south of the Golden Gate as far as Ventura, including the counties of Contra Costa, Alameda, Santa Clara, San Francisco, Santa Cruz, Monterey, San Luis Obispo, Santa Barbara, and Ventura; also San Benito and the western half of San Joaquin, Stanislaus, Merced, Fresno, and Kern Counties.

District 4 comprises the counties in southern California, namely, Los Angeles, Orange, Riverside, and San Bernardino.

District 4½ comprises the counties of Mono and Inyo.

District 4¾ comprises the counties of San Diego and Imperial.

Districts 23, 24, 25, and 26, all located in district No. 1, are as follows:

District 23 comprises the drainage area of Lake Tahoe and the Truckee River in the counties of Placer and Eldorado.

District 24 comprises the drainage area of Silver, Twin, Blue, Meadow, and Wood Lakes in the counties of Alpine and Amador.

District 25 comprises the drainage area of Lake Alamanor in the counties of Plumas and Lassen.

District 26 comprises Sixty Lake Basin, part of Rae Lake, and to the south fork of Woods Creek in Fresno County.

[4] For information in regard to bounties in any county, applications should be made to the county clerk.

COLORADO

Open seasons:	
Beaver	No open season.[1]
All other fur animals	Unprotected.[2]

Prohibited methods: No restrictions.

Licenses: Hunting license required to trap: Resident: General, $5; limited, $2 (for coyote, mountain lion, wolf, bobcat, lynx); nonresident, $25; issued by commissioner, county clerks, and other agents. Unnaturalized resident not permitted to hunt, capture, or kill any wild bird or animal.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Miscellaneous: Use of game or fish for trap bait prohibited.

Propagation: No restrictions, except as to beaver and game animals.

Bounties: None paid by State since 1895. On petition of 50 freeholders, county commissioners may levy a tax to pay bounties on coyote, wolf, and mountain lion.

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[1] *Colorado:* The owner of property being damaged by beaver may be permitted to kill them under such regulations as may be provided concerning disposition of the skins by the State game and fish commissioner.

[2] A permit from the State game and fish commissioner is necessary to take mountain lion, wolf, coyote, fox, lynx, wildcat, mink, marten, or wolverene on Colorado State Game Refuge.

CONNECTICUT

Open seasons:[1]	*Dates inclusive*
Muskrat	Nov. 1–Mar. 31.
Raccoon	Nov. 1–Jan. 31.
Fox, weasel	Unprotected.
Skunk, otter, mink, and other fur animals	Nov. 1–Mar. 15.

Prohibited methods: Unlawful to trap with scented baits or to take animals with a snare or similar device, to use steel traps having more than a 6-inch spread of jaws, or any steel trap having teeth except for otter. Unlawful to disturb muskrat house or den or to hunt muskrats from sunset to sunrise. Traps must be visited at least once in 48 hours, and, on lands of another, must not be set in path, wood road, or specially prepared furrow. Owner or person using traps must have his name legibly stamped thereon.

Licenses: Hunting license required to trap: Resident, $1.25 (after Jan. 1, 1926, fee, $2.25); nonresident, $10.25; issued by city, town, or borough clerk. Persons under 16 years of age are denied a hunting license, but may obtain one for taking fur animals only. License not required of residents hunting or trapping on own land during open season. Permission of owner required to trap on lands of another. Licensee required to report number of animals trapped each season. After January 1, 1926, taxidermist, $5; issued by board of fisheries and game.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No restrictions on possession or sale of fur animals kept in captivity under license (fee, $2).

Bounties: None paid.

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[1] *Connecticut:* Fox, skunk, raccoon, wildcat, mink, or weasel may be hunted or trapped on State game preserves only by superintendent of fisheries and game or persons designated by him. Fur animals may be killed at any time for protection of property.

DELAWARE

Open seasons:[1]	*Dates inclusive*
Skunk, mink, otter, muskrat	Dec. 1–Mar. 10.[2]
Fox	Oct. 1–Apr. 30.
Raccoon, opossum	Oct. 15–Jan. 15.

Prohibited methods: Unlawful to use pitfall, deadfall, scaffold, cage, snare, trap, net, pen, baited hook, or baited field or any other similar device, or any drug, poison, chemical, or explosive for taking animals protected by State laws, except muskrat, skunk, mink, and otter. Traps or other devices unlawfully set are subject to confiscation. Unlawful to destroy the nest, den, or lair of any animal protected by law. Unlawful to hunt, kill, take, or destroy any protected animal, except muskrat, skunk, mink,

DELAWARE—Continued

and otter, while the ground is covered with snow. Unlawful to shoot at or destroy any fox while it is being chased by a dog. Muskrats may not be taken during the time any flood or freshet may cause them to leave their usual places of shelter and protection, nor may they be shot at night, hunted with a dog, or taken by the method commonly known as "nailing."

Licenses: Hunting license required: Nonresident, $10.50; resident, $1.10 (not required in county of residence nor on own land); issued by commission. Permission of owner required to take or kill muskrats on land or marsh of another.

Possession and sale: Unlawful to sell fox or fox hide. No other restrictions.

Shipment and export: Unlawful to export fox or fox hide. No other restrictions.

Propagation: No restrictions, provided a permit is obtained from the chief game warden (fee. $1). A limited number of wild fur or game animals for propagating purposes may be taken under permit.

Bounties: None paid.

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[1] *Delaware:* Owners may kill foxes at any time when destroying their poultry, and other fur animals may be killed at any time when destroying property.

[2] In New Castle County, on embanked meadows, muskrats may be taken from December 1 to March 20.

DISTRICT OF COLUMBIA

No legislation relating to fur animals.

FLORIDA

Open seasons:	*Dates inclusive*
Beaver, otter	Nov. 1–Jan. 31.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to use pitfall, deadfall, cage, snare, net, blind, pen, baited hook, or similar device, or drugs, poison, chemical, or explosive for injuring or capturing animals protected by law.

Licenses: Resident, $1.25 (county of residence); $3.25 (county other than county of residence), $10.25 (State-wide license). Nonresident, $25 (county license, and $5.25 for each additional county). Issued by county judge. Permission of owner required to trap on inclosed land of another.

Possession and sale: No restrictions.

Shipment and export: No restrictions.

Propagation: No legislation.

Bounties: None paid.

GEORGIA

Open seasons: [1]	*Dates inclusive*
Beaver, mink, otter, bear, muskrat, raccoon	Nov. 20–Feb. 28.
Fox (red, gray)	Sept. 1–Jan. 31.
Other fur animals	No close season.

Prohibited methods: Fox dens protected during close season. Fox, skunk, or wildcat may not be taken by trap, deadfall, or similar device.

Licenses: Resident, $3; nonresident, $25; issued by commissioner or county warden. Permission of owner required to trap on lands of another.

Possession and sale: Prohibited during close season. Dealers must make such reports as may be required by commission.

Shipment and export: No restrictions.

Propagation: Permit from commissioner required to possess fur animals for propagation.

Bounties: None paid.

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[1] Fur animals destroying property may be killed at any time.

HAWAII

Hawaii has no wild animals valuable for fur. There are no restrictions on the propagation of fur animals except that mongooses and rabbits may not be kept or bred. Pet rabbits may be raised if kept in confinement.

IDAHO [1]

Open seasons: [2]	*Dates inclusive*
Beaver	No open season.[3]
Marten, fisher, otter, mink, raccoon, fox	Dec. 1–Mar. 1.
Muskrat in Bear Lake and Caribou Counties	Mar. 1–Apr. 13
In rest of State (except in irrigated districts, no close season)	Dec. 1–Mar. 1.
Other fur and predatory animals	Unprotected.[2]

Prohibited methods: Unlawful to destroy houses, dams, or other structures erected by fur animals.

Licenses: Resident, $5; nonresident, $25; alien, $50; issued by warden, deputy, or authorized agent. Licensed trapper must make verified report at end of season of number and kind of fur caught, where sold, and the price received. Unlawful to destroy, disturb, or remove traps of licensed trapper.

Possession and sale: [3] Skins of animals legally taken, within or without State, may be possessed or sold at any time. Unlawful to possess fur animals, or the hides thereof, on which there is no open season in the State, without permit from State game warden.

Shipment and export: No restrictions.

Miscellaneous: Unlawful to use flesh of any game animal for trap bait. Unlawful to destroy houses, dams, or other structures erected by fur animals, except under permit of State warden.

Propagation: Permit from State warden required. Permittee must make verified yearly report showing number of animals kept in captivity, number sold, and number on hand.

Bounties: None paid.

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[1] *Idaho:* State fish and game warden may close season in any locality on any species of fur-bearing animal threatened with extinction. Under permit of State warden, persons may protect their own premises from depredations of fur animals, except that bears doing damage may be destroyed without a permit.

[2] All trapping is prohibited on State game preserves, except that certain predatory animals may be killed thereon by deputy game wardens and persons authorized by State game warden.

[3] State game warden may grant permits to take beavers when doing damage to irrigation canals, crops, etc., or authorize deputy warden or State trapper to take such animals. Pelts of animals taken must be turned over to warden for sale, half the proceeds going to the permittee or person whose property is being damaged. Possession of beaver hides otherwise prohibited.

ILLINOIS

Open seasons: [1]	*Dates inclusive*
Otter, raccoon, skunk, opossum, fox in northern zone	Nov. 1–Feb. 15.
In central zone	Nov. 15–Feb. 1.
In southern zone	Nov. 15–Jan. 15.
Muskrat, mink, in northern zone	Nov. 1–Mar. 1.
In central zone	Nov. 15–Mar. 1.
In southern zone	Nov. 15–Feb. 15.
Other fur animals	Unprotected.

Prohibited methods: Houses, dens, and den trees of fur animals protected, except otter and muskrat dens which obstruct public or private ditches or watercourses. Unlawful to use spear or similar device for hunting or taking fur-bearing animals, or explosives, chemicals, or mechanical devices or smokers of any kind to drive them out of their burrows, dens, or houses. Use of automobile or vehicle propelled by mechanical power, or the lights thereof, or ferret, weasel, guinea pig, or rat, in hunting or taking fur-bearing animal prohibited.

Licenses: Resident citizen, $1; nonresident citizen, $10.50; issued by county, city, or village clerk. License not required of landowners and tenants and members of families to trap during open season on the lands on which they reside. License not issued to a person under 16 years of age without written consent of parent or guardian, nor to alien. Licensee, on or before April

ILLINOIS—Continued

15, must report all hides of fur animals taken, sold, shipped, or dealt in, together with names and addresses of persons to whom sold or shipped. Permission from owner, agent, or occupant required to trap on land of another.

Fur-buyer, $10; *wholesale fur-buyer*, $50. Issued by department of conservation. Buyer must keep daily register of all furs purchased.

Possession and sale: Possession of green hides (hides which have not been tanned) of fur animals permitted in each zone during the open season and 10 days thereafter. No other restrictions on possession and sale.

Shipment and export: No restrictions on skins legally taken and possessed.

Propagation: Permit required to conduct a fur farm on which protected animals are reared; fee, $2. Permit to breed and raise ferrets, fee, $10.

Bounties: None paid by State; counties may pay bounty on groundhog and crow.

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[1] *Illinois: Northern zone* comprises Henderson, Warren, Knox, Peoria, Woodford, Livingston, and Iroquois Counties and all counties north thereof. *Southern zone* comprises Madison, Bond, Fayette, Effingham, Jasper, and Crawford Counties and all counties south thereof. *Central zone* comprises all counties not included in the northern or southern zones.

INDIANA

Open seasons:[1]	*Dates inclusive*
Raccoon, fox, opossum, skunk, mink, muskrat	Nov. 10–Feb. 10.
Beaver, otter	No open season.

Prohibited methods: Traps set on land of another must be placed at least 18 inches within burrow or hollow log and must be visited at least once in each 36 hours. Muskrat houses protected except when obstructing ditches or watercourses. Unlawful to dig out fur-bearing animals or to chase them from their burrows by use of smoke, fumes, or chemicals.

Licenses: None required of residents; nonresident, $15.50; issued by clerk circuit court. Written consent of owner, occupant, or lessee required to trap on land of another.

Possession and sale: Possession of fur animals or green hides prohibited during close season, except that fresh skins may be disposed of during first five days of close season.

Shipment and export: No restrictions on skins legally taken and possessed.

Propagation: All animals raised in captivity are considered domestic stock, and the owner may possess, sell, ship, transport, or otherwise dispose of them without regard to laws regulating the killing and disposition of wild animals. Fur animals, lawfully acquired, may be possessed for breeding purposes during close season. An inspection certificate, fee $5, must be obtained from the department of conservation. Permit required to possess or harbor ferrets; fees, $10 for each single ferret and $5 for each additional one, issued by conservation department.

Bounties: Boards of county commissioners may pay bounty on wolf, fox, groundhog, crow, owl, or hawk.

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[1] *Indiana:* Protected fur animals may be killed at any time on one's own premises to protect property. The destruction of such animals, however, must be reported to the department of conservation within five days, and if hides are preserved, they must be sent to the department or arrangements made for their disposition.

IOWA

Open seasons:[1]	*Dates inclusive*
Beaver, mink, otter	Nov. 15–Mar. 15.
Raccoon, skunk	Nov. 1–Jan. 31.
Muskrat	No open season.[2]
Other fur animals	Unprotected.

IOWA—Continued

Prohibited methods: Use of poison prohibited; skunk dens and muskrat houses may not be injured or destroyed.

Licenses: Hunting license required to trap: Resident, $1; nonresident or resident alien, $10; issued by county auditor. License not issued to person under 18 years of age without written consent of parent or guardian. Owners of farm lands, their children, and tenants may trap on own land without license during open season. Permission of owner, occupant, or agent required to hunt or trap fur animals on cultivated or inclosed land of another.

Possession and sale: Skins of fur animals and parts thereof lawfully taken, within or without State, may be possessed and sold during the open season and 10 days thereafter, or at any time on proof of lawful possession, or upon filing an affidavit with the auditor of the county in which possessed, giving an inventory of such skins and stating when taken or from whom acquired and the location of premises where retained; provided that green hides in process of manufacture may be possessed at any time.

Shipment and export: Skins of protected fur animals legally taken may be exported during open season and first 10 days of close season.

Propagation: Breeder's permit, fee $2, must be secured from State game warden to propagate protected fur animals.

Bounties: Boards of supervisors of counties may allow bounty on crow, groundhog, pocket gopher, or rattlesnake.

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[1] *Iowa:* Fur animals may be destroyed at any time to protect public or private property.

[2] Expires Oct. 15, 1928.

KANSAS

Open seasons:	*Dates inclusive*
Muskrat, skunk, mink, opossum, civet cat	Dec. 2–Feb. 28.[1]
Raccoon	Nov. 1–Feb. 1.
Beaver, otter	No open season.

Prohibited methods: Ferrets, poisons, or use of smoke guns or other devices for forcing smoke, gas, or liquids into holes, dens, or runways, prohibited. Unlawful to destroy houses, dens, or runways of fur animals. Unlawful to set or maintain more than 30 traps, which must be visited daily.

Licenses: Resident, $1; issued by county clerk. Resident landowner and members of his family may hunt or trap on own land during open season without license. Trapping license not issued to nonresident or alien. Consent of owner or lessee required to hunt or kill wild animals on land of another.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: Quadrupeds raised in wholly inclosed preserve under license (fee $2) may be sold at any time for breeding or stocking purposes. Shipments must be tagged to show number and kind of animals, number of breeder's license, and names and addresses of consignor and consignee, and be accompanied by permits from State warden. Licensee required to make annual report of number of animals in possession. Wild animals may be captured during open season and thereafter had in possession for breeding purposes, under rules and regulations of State warden.

Bounties: Coyote, $1; wolf, $5; crow, pocket gopher, 10 cents each; jack rabbit, 5 cents each; crow eggs, 1 cent each; paid by county.

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[1] *Kansas:* Owner or legal occupant of land may destroy these animals at any time when they are destroying poultry or damaging other property.

KENTUCKY

Open seasons:[1]	*Dates inclusive*
Beaver, mink, raccoon, fox, otter, opossum, skunk	Nov. 15–Dec. 31.[2]
Other fur animals	Unprotected.

Prohibited methods: Traps must be set 18 inches or more within a hole, cave, or hollow log, and must be visited within each 36 hours.

Licenses: None required. Written consent of owner or lessee required to trap on lands of another.

Possession and sale: Possession of green skins during close season prima facie evidence of unlawful taking.

Shipment and export: No restrictions on skins legally taken.

Propagation: No legislation.

Bounties: None paid.

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[1] *Kentucky:* Fur animals may be killed at any time on one's premises to protect property.

[2] Raccoon, opossum, skunk, and mink may also be taken with gun or dog from Oct. 1 to Feb. 15.

LOUISIANA

Open seasons:[1]	*Dates inclusive*
Bear,[2] fox	Nov. 1–Jan. 31.
Muskrat, mink, otter, raccoon, skunk, opossum, badger	Nov. 15–Feb. 15.[3]
Beaver	No open season.
Wolf, wildcat, cougar	Unprotected.[4]

Prohibited methods: Unlawful to trap bear or fox at any time, or wolf, wildcat, or cougar from Feb. 16–Nov. 14; use of firearms for other fur animals prohibited. Unlawful to destroy muskrat houses and nests, lairs, or dens of other fur animals or to set traps within 10 feet thereof.

Bag limits: One bear a day, 5 a season.

Licenses:[4] Resident, trapping (does not include privilege of hunting), $1.25; issued by tax collector. Buyer, $5; resident dealer, $25; nonresident dealer, $50; issued by commissioner. Hunting license required to take bear, fox, wolf, wildcat, or cougar: Nonresident,[2] $50; resident, $1. Licensed trapper within 60 days after close of season must report to officer issuing license the number and kind of animals taken under license.

Possession and sale: Possession of raw or undressed furs prohibited from March 10 to November 14. Unlawful to possess furs without a license.

Shipment and export: All shipments must bear tags furnished by commissioner; no furs nor alligator skin may be shipped out of State except by holder of a dealer's license or by a trapper shipping his own catch; export of bear prohibited, except under written permission of the commissioner.

Miscellaneous: Use of birds for trap bait prohibited.

Propagation: Fur animals for breeding purposes may not be captured except under restrictions specified in permits issued by department of conservation. Permit from the department is required to import wild quadrupeds into the State or to export from the State.

Bounties: None paid.

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[1] *Louisiana:* Unlawful to take young of any fur animal whose pelt has no regular market value.

[2] Bears may be killed at any time on one's own land when actually damaging property.

[3] Muskrats may be killed at any time when damaging any levee, and, under permit of department of conservation, to prevent damage to cultivated or pasture land; any fur animal may be killed by the owner of land upon which it is destroying property.

[4] Wolves, wildcats, hunted for sport, may be taken in any manner at any time, and may be possessed by the lawful holder of a State hunting license.

MAINE

Open seasons:[1]	*Dates inclusive*
Muskrat (see exception)	Oct. 16–May 14.[2]
Exception: In Androscoggin, Cumberland, Kennebec, Knox, Lincoln, Sagadahoc, Waldo, and York Counties	Dec. 1–Apr. 30.
Beaver	No open season.[3]
Bear, bobcat, Canada lynx (loup cervier), weasel	Unprotected.
Raccoon,[4] skunk,[4] fox, and other fur animals	Oct. 16–Feb. 28.[2]

Prohibited methods: Unlawful to use snare, swivel, pivot, or set gun, or to put out poison for any animals. Traps may not be set within 25 feet of a muskrat or beaver house. Unlawful to dig out a fox den in close season or to set traps (except "water sets") within a half mile of compact or built-up portion of a city or village outside of own land. Owner's name and address must be either plainly stamped on the trap or on a metal tag firmly attached to it. A bear trap must be inclosed in a "hut," or surrounded with two strands of barbed wire, 5 yards distant from the trap, 4 and 5 feet, respectively, from the ground. Unlawful to disturb muskrat or beaver houses.

Licenses: Trapping $5 (in organized township); $10 (in unorganized places). License does not include beaver, and is not required for bobcat or Canada lynx. Not required of minor under 16, nor of resident or members of immediate family to trap on own land (except for beaver) in organized township. Issued by commissioner. Licensee, on or before December 31 of each year, must make such report as the commissioner may require. Written consent of the owner or occupant must be obtained before setting traps on the cultivated lands of another in an organized county or incorporated place; such traps must be visited at least once in every 24 hours and any animals caught removed. Traps must be stamped or bear metal tag to show full name and address of trapper.

Special beaver-trapping license, good only in territory opened to beaver trapping by commissioner, fee, $25.

Dealer in skins must be licensed (fee, State, $25; county, $2), and must keep a record of transactions and forward same to the commissioner of inland fisheries and game on or before December 20 of each year.

Possession and sale: Sale of beaver skins without seal of commissioner attached prohibited. No other restrictions on skins legally taken.

Shipment and export: Transportation of beaver skins without seal of commissioner attached prohibited. No other restrictions on skins legally taken.

Propagation: Permit required to raise fur animals (fee, $2 and $1 additional for each fox except red fox). Protected species may be taken under special permits for breeding purposes. No animals may be imported into the State without permit.

Bounties: Bobcat and Canada lynx (loup cervier), $10 each; paid by State; claim to be made within five days after killing or return from trip on which killing was done.

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[1] *Maine:* Any person may lawfully kill any wild animal, except beaver, found destroying his property.

[2] Special laws on muskrat, otter, fisher, and mink in certain localities in Cumberland, Hancock, Kennebec, Oxford, Sagadahoc, and Washington Counties. For detailed information apply to Commissioner of Inland Fisheries and Game, Augusta.

[3] Commissioner of inland fisheries and game, upon written complaint of owner of timberland that beavers are doing substantial damage to his property, may declare special local open season on them (*see* "Licenses").

[4] Raccoons after October 1, and skunks after October 15, may be hunted at night.

MARYLAND

Open seasons: *Dates inclusive*
Otter, muskrat.................. Jan. 1–Mar. 15.
Other fur animals unprotected, except locally, as follows:
Raccoon:
In Allegany County, Sept. 1–Mar. 31: in Anne Arundel and Prince Georges Counties, Oct. 1–Jan. 31 [1]; in Baltimore County, Oct. 1–Feb. 28 [2]; in Carroll County, Oct. 1–Jan. 1; in Caroline County, Sept. 15–Mar. 31; in Dorchester County, Nov. 10–Mar. 15; in Frederick County, Nov. 15–Mar. 1; in Harford County, Nov. 1–Jan. 1; in Kent, Queen Anne, and Somerset Counties, Jan. 1–Mar. 31; in Montgomery County, Oct. 15–Jan. 14; in Wicomico and Worcester Counties, Oct. 1–Feb. 1.
Opossum:
In Allegany County, Sept. 1–Mar. 31; in Baltimore County, Oct. 1–Feb. 28 [2]; in Carroll County, Oct. 1–Jan. 1; in Frederick County, Nov. 15–Mar. 1; in Montgomery County, Oct. 15–Jan. 14; in Washington County, Dec. 1–Mar. 31; in Wicomico and Worcester Counties, Oct. 1–Feb. 1.
Mink:
In Frederick County, Nov. 15–Mar. 1; in Washington County, Dec. 1–Mar. 31; in Worcester County, Dec. 15–Mar. 1.
Skunk:
In Frederick and Washington Counties, unprotected.
Fox:
In Frederick County, Nov. 15–Mar. 1; in Caroline [3] and Carroll [4] Counties, no open season; in Worcester County (chase with dogs), Sept. 1–Mar. 9.
All fur animals (except as above mentioned):
In Frederick County, Nov. 15–Mar. 1 [5]; in Harford County (trapping), Nov. 15–Dec. 24.

Prohibited methods: Unlawful to take or kill otter or muskrat in any manner, except by gigging or trapping; to dig for muskrat or in any manner molest or destroy any part of a muskrat house or den. County restrictions as follows:

Anne Arundel and Prince Georges Counties.—Unlawful to cut down tree to obtain a raccoon.

Baltimore, Carroll, and Harford Counties.—Unlawful to hunt raccoon and opossum in Baltimore and Carroll Counties and raccoon in Harford County when snow covers the ground, or to set steel trap for raccoon in Harford County.

Baltimore, Calvert, Carroll, Prince Georges, St. Marys, Wicomico, and Worcester Counties.—Unlawful to shoot fox while it is being pursued by dogs.

Wicomico and Worcester Counties.—Unlawful to take raccoon or opossum with steel trap or similar device.

Licenses: Hunting license required to trap: Resident, State, $5.10; county, $1.10; nonresident, $10.50 (fee $5.10 for State license if applicant owns real estate in Maryland assessed at $500; $1.10 for county license in county where such real estate is located); issued by clerk of circuit court—in Baltimore City by clerk of court of common pleas. Licensee required to wear tag displayed on middle of back and to carry license on person. License not issued to persons under 14 years of age without written request of parent or guardian. Owners, tenants, and their children may hunt on own land during open season without license.

Written consent of owner required to trap on land of another in Cecil, Frederick, Washington, and Worcester Counties.

Possession and sale: Possession of green hides of otter or muskrat prohibited except from January 1 to March 25. No other restrictions on possession and sale of skins legally taken. County restrictions as follows:

Allegany and Baltimore Counties.— Possession of raccoon and opossum prohibited during close season.

Anne Arundel and Prince Georges Counties.—Possession of raccoon prohibited during close season.

Harford County.—Sale of raccoon for export from county prohibited.

Shipment and export: No restrictions on skins legally taken and possessed, except that raccoons may not be removed from Harford County.

Propagation: No legislation.

Bounties: A State bounty of 50 cents each on bird hawk, or chicken hawk, killed in State, paid from State game-protection fund.

Allegany County.—Wildcat, $2; fox, $1; hawk or hoot owl, 50 cents.

Garrett County.—Wildcat, fox, $2; weasel, 50 cents; paid by county commissioners.

MASSACHUSETTS

Open seasons: *Dates inclusive*
Mink, otter, muskrat, skunk, raccoon (see exceptions)...... Nov. 1–Mar. 1.
Exceptions: Raccoon may also be hunted with dog and gun during October.
In Dukes and Nantucket Counties.................. No close season.
Other fur animals.............. Unprotected.

Prohibited methods: Unlawful to open, disturb, or destroy muskrat house or to set trap within 10 feet thereof. Traps must be marked legibly with owner's name and must be removed at end of open season. Poison may not be used to kill animals, except rats, woodchucks, or other pests on one's own premises. The use of steel traps with spread of over 6 inches and "choke" traps with greater opening than 6 inches is unlawful, as is also the use of snares or, except by landowner, of scented baits. Except as otherwise stated, fur animals may only be taken by shooting or trapping.

Bag limits: Twenty-five raccoons a season.

Licenses:[1] Hunting license required to trap: Resident citizen, $1.50; nonresident citizen, $10; alien, $15 (alien applicant must own real estate to the assessed value of $500); issued by city or town clerks. License not issued to minors under 15 years of age, and those under 18 must apply in writing and furnish written consent of parent or guardian. License (fee, 25 cents) to trap quadrupeds, in discretion of issuing officer, may be issued to any citizen between the ages of 12 and 18. License not required of resident on own land used exclusively for agricultural purposes and on which he is actually domiciled. The following nonresidents pay a fee of $1.50: Members of incorporated game clubs owning real estate assessed at not less than $500 for each member and which were organized prior to 1907; owners, or their minor children over 18 years of age, of real estate assessed at not less than $500; or nonresidents invited (for not more than four days) by members of incorporated clubs for hunting foxes. Trappers must report catch to director on or before January 10 each year.

Written consent of owners required to trap on improved or posted land of another. Traps must be visited at least once in 24 hours. Animals may be removed from traps on Sunday, but traps may not be set or reset on such day.

Possession and sale: No restrictions on skins legally taken during open season.

Shipment and export: No restrictions on skins legally taken during open season.

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[1] *Maryland: Anne Arundel and Prince Georges Counties.*—Raccoon may not be taken between sunrise and sunset.

[2] *Baltimore County.*—Unlawful to set traps, except from Nov. 10 to Dec. 20, for mink, weasel, skunk, raccoon, opossum, or fox. Permits to take certain predatory fur animals when destroying property may be obtained.

[3] *Caroline County.*—Unlawful to kill a fox except by hounds in a hunt or when the fox is destroying poultry.

[4] *Carroll County.*—Landowner or tenant may kill a fox on own land at any time, except when such fox is pursued by hounds followed by hunters.

[5] *Frederick County.*—Raccoons or opossums may be hunted with dogs at night at any time. Landowners may protect property from ravages of fur animals.

MASSACHUSETTS—Continued

Miscellaneous: Introduction of fox or raccoon in Dukes County prohibited.

Propagation: May be permitted under regulations of division of fisheries and game.

Bounties: Seal, $2 (by Commonwealth); wildcat or lynx, $10; paid by town, but refunded by county.

MICHIGAN

Open seasons:[1]	*Dates inclusive*
Beaver, otter, mink, fisher, marten, muskrat	No open season.[1]
Bear	Nov. 15–Nov. 30.
Skunk	Nov. 1—Mar 31.
Raccoon	Oct. 2–Dec. 31.
Wolf, coyote, fox, lynx, wildcat	Unprotected.

Prohibited methods: Unlawful to trap bear, or to use spears, baited hooks, explosives, chemicals, mechanical devices, or smokers to drive animals from their holes or homes; or to destroy, disturb, or molest any beaver, skunk, or muskrat houses or holes.

Bag limits: One bear a season.

Licenses: Resident, $1.25; nonresident, $10; issued by county clerk. A hunting license also permits the holder to trap fur-bearing animals, except beaver and bear. Resident citizens and their minor children under 17 years of age may hunt or trap during open season on own inclosed lands upon which they live, without a license. License to hunt or trap on other lands issued to minors over 12 and under 17 on application of parents or guardian, but such licensed minors while hunting or trapping must be accompanied by parent or guardian. Alien prohibited from hunting or taking any wild animals in State. Big game license required to take bears: Nonresident, $50; resident, $2.50.

Possession and sale: Possession of the carcass or skin of fur animals killed in close season prohibited.

Shipment and export: No restrictions on skins legally taken, possessed, or tagged.

Propagation: Annual license (fee, $5) required to engage in raising fur animals. Live animals and skins of animals raised in captivity must be tagged (fee, 5 cents for each tag).

Bounties: None paid.

MINNESOTA

Open seasons:[1]	*Dates inclusive*
Fisher, skunk	Nov. 15–Mar. 1.
Beaver,[2] otter, raccoon, muskrat[3]	No open season.
Bear, mink, weasel, wolf, wildcat, lynx, fox	Unprotected.

Prohibited methods: Use of poison prohibited, except as permitted by commissioner. Unlawful to molest or destroy muskrat or beaver house, den, dam, or abiding place; to hunt these animals with dogs; or to take muskrats in any manner except by trapping, but muskrat houses must not be destroyed in placing traps therein. Unlawful to dig out or take red-fox cubs from dens. Black bear may not be taken by use of steel traps, except under permit of commissioner.

Licenses: Resident only, fee, $1; issued by county auditors; not required of persons under 18 years of age; commissioner may issue license (fee, $1; bond, $500) to trap a specified number of beaver at a designated time and place; licensee must report the taking of beaver within 15 days and obtain tag from commissioner, fee, $1.50. Licensed trapper required to make report within 30 days after his license expires showing number of each kind of fur animal taken thereunder. Owners, lessees, or members of their immediate families may trap without license during open season on own or leased land occupied by them as a permanent residence. Unlawful to enter growing grain for purpose of killing any wild animal without permission of owner. *Buyer:* Resident, local, $1; traveling, $10; nonresident, $25; wholesale, $1. Applicant for fur-buyer's license must furnish $1,000 bond. *Buyers* must make reports.

Possession and sale: Skins of beaver legally taken, when tagged (fee, $1.50), and skins of other fur animals legally taken if tagged within five days after close of season, may be possessed, bought, or sold at any time. Possession in close season without tags prohibited.

Shipment and export: Skins of beaver legally taken, when tagged (fee, $1.50), and other skins legally taken may be transported at any time. Export of red fox cubs taken in State prohibited. Package or receptacle containing wild animals or parts thereof when transported by a common carrier must have attached a proper coupon tag bearing signature, address, and license number of shipper, together with number and kind of animals or parts thereof contained therein or if shipped by owner or occupant of land a signed statement that "The contents of this package were taken from animals killed on my land."

Propagation: Wild animals raised in captivity under a $1 permit from the State game and fish commissioner may be sold for breeding or stocking purposes at any time, and under regulations of the commissioner may be killed and any part thereof sold or transported. Under regulations of the commissioner, wild animals may be captured for breeding purposes.

Bounties: Wolf, $15; cub wolf, $6; paid by State. County or town boards may offer bounty on wolf, gopher, ground squirrel, groundhog, rattlesnake, crow, or blackbird.

MISSISSIPPI[1]

Laws of 1925 not received

Open seasons:	*Dates inclusive*
Bear	Nov. 15–Mar. 1.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to trap bears.

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[1] *Massachusetts:* Effective January 1, 1926: Nonresident citizen, $15.25. Nonresident, residing in a State affording similar privileges to residents of Massachusetts, who owns real estate assessed at not less than $500, or who is a member of a hunting or fishing club or association incorporated prior to 1907, or who is a guest on written invitation of an incorporated club or association for hunting foxes, $5.25. Alien, $15.25 (applicant must have resided in State 10 days and own real estate therein to the assessed value of $500).

Resident citizen, $2.25 (not issued to minors under 18; and those between ages of 12 and 18, on written application and consent of parents or guardians, may obtain trapping license, fee, 75 cents, in discretion of issuing officer. Resident may trap during open season without license on land owned or leased on which he is actually domiciled and which is used exclusively for agricultural purposes, and not for club, shooting, or fishing purposes. Duplicate of lost or destroyed license, fee, 50 cents. Licenses issued by city and town clerks.

Licensee, during month of January, must make written report of number of fur animals trapped during preceding year.

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[1] *Michigan:* Season on beaver, otter, fisher, and marten closed until 1930, and on mink and muskrat until 1927. Fur animals, except beaver, may be destroyed under permit from director, on one's own premises to protect property, but hides must be properly cared for and turned over to the director at expiration of permit. Unlawful to trap on State game preserves or to trap beaver, badger, or muskrat, in and within 2 miles of any city public park containing over 200 acres, of which 150 acres or more is woodland.

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[1] *Minnesota:* Wild animals other than beaver causing injury to property may be taken at any time under permit of the commissioner, who may also issue permits to take unprotected animals on game refuges.

[2] A limited number of beavers may be taken under a special license from the commissioner (*see* "Licenses").

[3] Under regulations commissioner may permit the taking of muskrats in shallow lakes or sloughs when it may be shown they are in immediate danger of freezing or starvation.

MISSISSIPPI—Continued

Licenses: Nonresident, $20 (county license, bears only); issued by sheriff. Landowners and their nonresident relatives and friends may hunt without license during open season on own lands.

Possession and sale: Sale of bears prohibited.

Shipment and export: Export of bears prohibited. All packages containing dead animals, or parts thereof, shipped within the State shall be open to view, clearly marked with names of the consignor and consignee, and an itemized statement of the number of each species.

Propagation: No legislation.

Bounties: None paid.

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[1] *Mississippi:* The game and fur law enacted in 1922 does not become effective in any county until adopted by the board of supervisors. For information as to whether any boards have adopted the act, address sheriff or county clerk at the county seat of each county. The provisions of the law relating to fur animals are as follows:

Open seasons: Bear, Nov. 1–Fed. 28; fox, Sept. 1–Mar. 31; raccoon, muskrat, otter, skunk, weasel, Nov. 1–Jan. 31; beaver, protected to Jan. 1, 1930; opossum, wildcat, and other fur animals unprotected.

Licenses: Resident, $10 (not required of person under 16 years of age); nonresident (county license), $100, issued by sheriff. Written consent required to trap on lands of another, and traps must be visited once in every 36 hours.

Bag limits: One bear a season.

Possession and sale: No restrictions, except that green hides may be possessed only during the open season and the first 10 days of the close season.

Shipment and export: Export of bear prohibited.

MISSOURI

Open seasons:	*Dates inclusive*
All fur animals	Dec. 1–Jan. 31.[1]

Prohibited methods: Use of poison or smoke device in taking any protected animal prohibited.

Licenses: Hunting license required to trap: Resident, State, $2.50; county, $1 (good in county of residence or adjoining county); issued by county clerk or license collector. Nonresident or alien, $10. Fur dealer, $5. Issued by commissioner. Written permission required to trap on inclosed premises of another.

Possession and sale: Possession and sale of green pelts prohibited during close season, but dry pelts may be possessed and sold during open season and first 10 days of close season.

Shipment and export: Shipper must show hunting license to transportation company. Furs taken out of season may not be possessed for any purpose. Dried pelts may be shipped during first 10 days of close season. Shipments must be marked with the name and address of shipper, his license number, date of shipment, and nature of contents.

Propagation: Permits to capture fur animals for propagating purposes may be obtained from the State game and fish commissioner; fee, $5; breeder's permit fee, $5.

Bounties: None paid.

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[1] *Missouri:* Fur animals may be destroyed at any time and in any way by person residing on own land to protect premises from depredations, but pelts of animals so killed may be marketed in season only.

MONTANA

Open seasons:[1]	*Dates inclusive*
Fisher, otter, sable, muskrat,[2] mink, raccoon, fox	Nov. 1–Apr. 30.
Beaver,[3] marten[4]	No open season.
Other fur and predatory animals	Unprotected.

Prohibited methods: Unlawful to capture or kill any fur animal from an automobile or by aid or use of a set-gun, jack, or other artificial light, or dog. Beaver and muskrat houses protected from injury.

MONTANA—Continued

Licenses: Trapping license, $10 (issued only to holder of a $2 resident general hunting license); special permit required to trap beaver on own land when doing damage or to export their skins; special license (trapping on State game preserves), $5; issued by State game warden. Trapping license not required of minors between the ages of 14 and 18 years who hold resident general hunting licenses. Taxidermist, $15.

Possession and sale: Sale and shipment of beaver skins prohibited, except that skins legally taken under permit and tagged may be shipped or sold within State or they may be exported under permit from the State game warden. No other restrictions on skins legally taken.

Shipment and export: (See Possession and sale and footnote 3.) No restrictions on skins legally taken, possessed, or tagged. Permit required to ship out furs; packages must be marked to show contents.

Propagation: Fur-farm license, $5.

Bounties: The livestock commission may make regulations governing the payment of bounties.

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[1] *Montana:* Commission may create fur-bearing animal districts and restrict or prohibit trapping therein.

[2] Muskrats doing damage may be taken under permit of commission, except that permit is not required from June 1 to August 31.

[3] Unlawful to kill beaver except when doing damage to own land under a special permit from the State game warden (fee, $10). All skins of animals so taken must be properly cured and forwarded to the State game warden, Helena, to be tagged with a numbered metal tag (fee, 50 cents for each tag). Tagged skins may be sold or shipped within State, but a shipping permit (fee, 50 cents) must be attached to each shipment sent out of the State.

[4] Season closed on marten until opened by commission.

NEBRASKA

Open seasons:[1]	*Dates inclusive*
Muskrat, otter, mink, fox	Nov. 16–Mar. 1.
Raccoon, opossum	Nov. 1–Feb. 15.
Beaver	Nov. 1–Jan. 31.[2]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to use spear or like device in hunting or taking fur animals, or explosives, chemicals, mechanical devices, or smokers of any kind, or ferrets to drive fur animals from holes, dens, or houses. Unlawful to disturb or destroy den or house of fur animal, except of muskrat or otter obstructing a public or private ditch or watercourse; unlawful to cut down or into any tree containing a den.

Licenses: Resident, $2.10; nonresident or alien, $25.10; buyer, $1; issued by State department of agriculture and authorized vendors.

Possession and sale: Possession of green hides prohibited, except during open season and 30 days thereafter. Beaver skins coming from without the State, upon being inspected and stamped by State warden, may be possessed and sold at any time. No other restrictions on skins legally taken.

Shipment and export: Green hides may be transported by express, baggage, or mail during open season and 30 days thereafter, if package is labeled (in two places) with name of consignor, number of his trapping license, and number and kind of hides. No other restrictions on skins legally taken.

Propagation: Fur animals raised in captivity under $2 breeding license may be sold alive and transported for breeding purposes, and the skins, when tagged and labeled with name of licensee, number of license, and kind and number of skins may be sold and transported at any time.

NEBRASKA—Continued

Bounties: Counties that have voted at any general election to pay bounties may pay for wolf, $6; mountain lion, $3; wildcat, $1. It is also optional with county boards to pay bounties of $2 on coyotes and 10 cents each on crows.

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[1] *Nebraska:* Fur animals, except beaver, may be taken at any time necessary for the protection of property.

[2] Beaver damaging property may be killed on own land from August 1 to October 31, and under a permit from chief game warden may be killed at any time, but such killings must be reported to State department of agriculture.

NEVADA

Open seasons:[1]	*Dates inclusive*
Beaver,[1] otter	Jan. 1, 1930.
Bear, raccoon, marten, fisher, mink, skunk, fox	Nov. 15–Mar. 15.

Prohibited methods: Unlawful to take fur animals in any manner except by trap or gun, to dig out or drive skunks from dens by use of chemicals, or to molest or destroy any muskrat nest.

Licenses: Hunting license required: Resident citizen, $1.50; nonresident citizen, $10. Licence not required of minors under 14, nor of persons trapping on own land.

Possessions and sale: Unlawful to possess beaver or otter skins unless it can be shown that they were legally taken. No other restrictions.

Shipment and export: No restrictions on skins legally taken.

Propagation: Game or fur animals (except beaver); raised in a licensed preserve (fee, $10) may be sold or shipped at any time under invoice.

Bounties: Mountain lions, $5; lynx or wildcat, $2, paid by county. Counties pay bounty of 1½ cents each for pocket gophers when at least 100 heads are presented at one time.

The State board of livestock commissioners is authorized to pay bounty from funds derived from tax on horses, cattle, and hogs. The reward for coyote, coyote pup, wildcat, or lynx are 75 cents each; for mountain lion, $5.

The State board of sheep commissioners is authorized to pay bounty from funds derived from tax on sheep, the payments being the same as those made by board of livestock commissioners.

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[1] *Nevada:* Beavers doing damage to property may be trapped under authorization from the board of county commissioners. Furs of animals so taken must be preserved and turned over to the board for sale, half of the proceeds to be returned to the trapper. Other fur animals injuring property may be killed in any manner at any time.

NEW HAMPSHIRE

Open seasons:[1]	*Dates inclusive*
Sable, otter, fisher, mink, marten, muskrat,[2] skunk, fox,[3] (see exception)	Nov. 1–Feb. 28.
Exception: In Carroll, Coos, and Grafton Counties	Oct. 10–Feb. 28.
Raccoon	Nov. 1–Dec. 31.[3]
Beaver	No open season.
Other fur animals	Unprotected.

Prohibited methods: Bear traps must be safeguarded in a substantial manner. Use of set guns or snares is prohibited. Unlawful to destroy a muskrat house or set a trap therein, thereon, or at the entrance thereof.

Licenses: Resident, $2.15, nonresident, $25.15, issued by commissioner or agents. License not required of resident landowners and their minor children to trap on own farmlands during open season. No person may trap on lands of which he is not the owner or lessee without permission of owner. All metal traps must be legibly marked or stamped with the trapper's name, and must be visited at least once every 24 hours. Unlawful to take traps of another or to remove fur animals from them. Trappers are liable for any damage to domestic animals by traps.

NEW HAMPSHIRE—Continued

Possession and sale: Possession of fur animals permitted only during open season, but skins legally taken may be bought or sold at any time.

Shipment and export: No restrictions on skins legally taken and possessed.

Miscellaneous: Unlawful to tear down or destroy any fence or wall, leave open any gate or bar, or trample or destroy any crop on land of another while trapping or pursuing wild animals.

Propagation: Permit (fee, $2) required to propagate fur animals, game, or fish.

Bounties: Bear, $5; hedgehog, 20 cents; wildcat, $20; paid by State, through the selectmen of towns.

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[1] *New Hampshire:* Fur or predatory animals may be killed at any time when destroying domestic animals or fowls.

[2] Muskrats may also be taken from the waters of the Connecticut River during the month of March.

[3] Raccoons and foxes may also be taken by use of dog and gun during the month of October.

NEW JERSEY

Open seasons:	*Dates inclusive*
Skunk, mink, muskrat,[1] otter	Nov. 15–Mar. 15.
Raccoon	Oct. 1–Dec. 15.
Beaver	No open season.
Other fur animals	Unprotected.[2]

Prohibited methods: Muskrat, skunk, mink, and otter may be taken by trap only. Unlawful at any time to disturb the lodge or nesting chamber of muskrat. Raccoon may not be trapped, but may be hunted with dogs and firearms, without permit, from sunset to sunrise in season.

Licenses: Hunting and fishing license required to trap: Nonresident, $10.50; resident, $1.65. Issued by county, city, or town clerk, salaried wardens, or registrars of licenses. Resident minors under 14 may trap without license. Occupant and immediate members of his family residing on farm may trap thereon without license during open season.

Possession and sale: Possession of raccoon permitted during open season and 10 days thereafter, but skins legally taken may be possessed and sold at any time. Possession of live fox prohibited except by permission of board of fish and game commissioners.

Shipment and export: Export of raccoon prohibited, except by nonresident licensee, but pelts of raccoon legally taken may be exported at any time. No other restrictions on skins legally taken or possessed.

Miscellaneous: Unlawful to molest trap set by another or to take animal caught in such trap. Unlawful to liberate fox in State.

Propagation: Raccoon may not be raised or kept in captivity; no other restrictions except those imposed by close seasons, during which fur animals may not be taken for breeding purposes.

Bounties: Fox, $3; woodchuck, amount, not exceeding 50 cents, fixed by boards of chosen freeholders; paid by counties.

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[1] *New Jersey:* Muskrats may be killed at any time by owner of canal or dam which they are destroying.

[2] Foxes may be hunted with hounds and firearms in daylight from November 10 to April 30, except during open season for deer (December 17 to 21). Killing of fox must be reported to commissioners or county warden within 48 hours.

NEW MEXICO

Open seasons:	*Dates inclusive*
Beaver	No open season.[1]
All other fur animals	Unprotected.

Prohibited methods: No restrictions.

Licenses: None required.

Possession and sale: No restrictions on skins legally taken.

NEW MEXICO—Continued

Shipment and export: No restrictions on skins legally taken.
Propagation: Permit from State game warden required.
Bounties: None paid by State.

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[1] *New Mexico:* When destroying property beaver may be killed under permit from State game and fish warden.

NEW YORK

Open seasons:	*Dates inclusive*
Bear	Oct. 15–Nov. 15.
Mink, sable	Nov. 10–Mar. 15.
Skunk	Nov. 10–Feb. 10.[1]
Muskrat (see exception)	Dec. 1–Mar. 31.
Exception: In Clinton, Essex, Franklin, Hamilton, Jefferson, Lewis, St. Lawrence, Warren, Washington, and that portion of Herkimer County north of the towns of Ohio and Russia	Dec. 1–Apr. 30.
Raccoon (in Orleans County, no open season)	Nov. 10–Feb. 10.
Beaver	No open season.[2]
Otter, fisher, fox	No close season.

Prohibited methods: Use of chemicals, gas, or other poisonous substances prohibited. Skunks may not be taken by the aid of dogs or by digging out or driving them from dens or holes by smoking. Unlawful to kill muskrats by shooting, except they may be taken with a 22-caliber rifle in the counties bordering upon Lake Champlain; to take them in box, wire, or cage traps; or to molest, injure, or disturb muskrat houses or dens. Raccoons may not be taken from dens or houses, or by cutting den trees.
Bag limits: One bear a season.
Licenses: Resident, $1.25; nonresident, $10.50; issued by county, city, town, or village clerks. Owners or lessees and members of immediate families actually occupying cultivated farm lands may trap fur animals thereon without license during open season. Minors under 16 may trap fur animals without a license. Indian resident or member of Six Nations residing on reservation wholly or partly within State, fee $1.25. Only licensed Indians residing on a reservation may take fur animals thereon. Alien not permitted to hunt or kill wild animals except under special license from the conservation commission, or to own or possess shotgun or rifle.
Possession and sale: Fur animals may be possessed during open season only, but hides of fur animals legally taken and possessed may be bought or sold at any time.
Shipment and export: Shipment and export prohibited, except hides of fur animals legally taken and possessed may be transported at any time.
Miscellaneous: Traps used for taking fur animals protected by law may not be staked or set during close season.
Propagation: Protected fur animals may be kept alive in captivity for propagation and sale, under license from the conservation commission (fee, $5). No fur-bearing animals may be kept, which are taken wild during close season for such animals (unless taken under license); nor may they be disposed of during close season. The conservation commission is authorized to issue license to capture animals for propagation; fee for permit, $1. License to breed or sell ferrets, fee, $10; to possess ferret without breeding, fee, $2.
Bounties: None paid.

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[1] *New York:* If injuring property, skunks may be taken at any time and in any manner, but the skins of animals so taken shall not be possessed, sold, bought, or trafficked in.

[2] In sections of State designated by conservation commission beaver may be trapped from March 1 to March 31.

NORTH CAROLINA

[More than half of the 100 counties in the State have local laws relating to fur animals. Information regarding open seasons, license requirements, and trapping and hunting restrictions in the various counties may be obtained from the Legislative Reference Librarian, Raleigh.]

NORTH DAKOTA

Open seasons:	*Dates inclusive*
Mink	Nov. 16–Apr. 14.[1]
Muskrat	Jan. 10–Mar. 10.
Beaver, otter	No open season.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to cut into, molest, destroy, or dynamite any beaver dam or beaver or muskrat house or mound, or to shoot muskrats.
Licenses: Resident, $2; nonresident, $25; issued by commissioners, deputies, and county auditors. License not required of persons under 16 years of age, or of residents or members of family residing permanently with him, to trap on own cultivated land, during open season. Unlawful to trap muskrats on posted lands of another. Aliens prohibited from hunting, taking, or killing any wild animal, except in defense of person or property.
Possession and sale: Skins of fur animals legally killed within or without the State may be possessed or sold at any time. Green hides of mink or muskrat may be possessed only during open season and first five days of close season.
Shipment and export: Shipment and export prohibited, except that skins of fur animals legally taken within or without the State may be shipped at any time.
Propagation: The State game and fish board issues permits (fee, $5) to breed and domesticate fox, mink, muskrat, skunk, and raccoon, and also permits to sell or ship them when raised in captivity. Under permit from board and $500 bond, such fur animals may be taken at any time for breeding purposes. Annual reports are required of licensed breeders.
Bounties: Adult wolf or coyote, $5; pups, $2 each.

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[1] *North Dakota:* Minks may be killed at any time to protect one's own property.

OHIO

Open seasons:[1]	*Dates inclusive*
Raccoon, fox, skunk, opossum	Nov. 15–Feb. 1.
Mink	Nov. 15–Mar. 1.
Muskrat	Nov. 15–Mar. 15.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to dig out or destroy the house, den, or burrow of fur animals or to smoke or drown the animals therefrom.
Licenses: Resident, $1.25; nonresident, $15; issued by county and township clerks. Alien prohibited from hunting or trapping. License not required of owners, managers, tenants, or their children to trap during open season on own land. Written permission from owners or authorized agents required to trap on lands of another.
Possession and sale: Possession of fur animals during close season prohibited, but skins legally taken may be possessed or sold at any time. Raccoons legally taken may be possessed alive in inclosures as pets.
Shipment and export: Shipment and export prohibited, except that skins legally taken may be transported at any time. Packages containing fur animals or parts thereof when transported by common carrier must be marked to show contents, initial point of billing, and names and addresses of consignor and consignee.
Propagation: No restrictions, except those which prevent capture of wild stock in close season.
Bounties: Townships pay a bounty of $1 each on certain hawks and the great horned owl, and 25 cents on crows.

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[1] *Ohio:* Protected fur animals, when damaging property, may be destroyed by owners or tenants of land (except on Sunday).

OKLAHOMA

Open seasons:	*Dates inclusive*
Beaver, otter	No open season.
Bear (see exception)	Unprotected.
Exception: In Blaine, Caddo, Comanche, Kiowa, and Major counties	No open season.
Other fur animals	Nov. 1–Mar. 1.

Prohibited methods: No restrictions.

Licenses: None required.

Possession and sale: Unlawful to sell pelts of fur animals taken during close season. No other restrictions.

Shipment and export: No restrictions on skins legally taken.

Propagation: The State game warden issues permits to propagate fur-bearing animals (fee $2, together with fees for tagging). Licensed breeders may sell and transport animals raised in preserves under rules prescribed by the warden.

Bounties: County commissioners are authorized to offer bounty on gray wolf or coyote ($5), and may also pay bounty of not exceeding 5 cents each on crows, English sparrows, hawks, rabbits, prairie dogs, pocket gophers, and ground squirrels.

OREGON

Open seasons: [1]	*Dates inclusive*
Beaver, west of Cascades (except in Coos, Curry, Jackson, and Josephine Counties, and east of a line through town of Scottsburg in Douglas County, and south of Portland-Astoria highway in Clatsop and Columbia Counties, no open season); east of Cascades in Crook, Deschutes, Jefferson, Klamath, and Lake Counties only	Dec. 1–Feb. 28. [2]
Mink, otter, fisher, marten, muskrat, raccoon	Nov. 1–Feb. 28. [2]
Bear in Jackson, Josephine, and Klamath Counties—no close season elsewhere	Nov. 1–Nov. 30.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to destroy muskrat house, except where it obstructs ditch or watercourse.

Licenses: Fee, $2; issued by State game commission. License not required for trapping on own land. Special beaver trapping license, fee, $2. Fur dealer, $3. Licensee must keep chronological record showing number and kind of furs purchased, and names and addresses of persons from whom obtained, and make verified annual report to commission. Unlawful to remove or disturb traps of a licensed trapper on public domain or on land where he has permission to trap. Licensed trappers are required to make verified annual reports of number of animals caught; receipts for fur, and where sold.

Possession and sale: Possession and sale prohibited, except that animals or hides legally taken within or without the State may be possessed or sold at any time.

Shipment and export: Shipment and export prohibited, except that skins of animals legally taken may be shipped at any time.

Miscellaneous: Unlawful to use the flesh of a game bird or animal for trap bait.

Propagation: Permit (fee, $2) to keep fur-bearing animals may be obtained from the State game commission. No wild fur animals may be taken for propagating purposes in close season nor may those held in captivity under permit be sold in that season. Yearly reports to the commission are required.

Bounties: Coyote or coyote pup, $3; adult female coyote, $4; gray, black, or timber wolf, or wolf pup, $2.50; bobcat, wildcat, or lynx, $2; mountain lion, panther, or cougar, $10; seal or seal pup (including only hair, spotted, or leopard seals), $2.50; paid by county and half refunded by the State. The State game commission is empowered to pay additional bounties on any predatory animal in order to protect game; under this act it now pays for wolf, $20; for cougar, $15. Several counties are authorized to pay bounties on moles, rabbits, and gophers.

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[1] *Oregon:* Unlawful to hunt or trap fur animals on State game preserve.

[2] Unlawful to trap beavers in national forests. Beavers doing damage may be killed on own or leased property, but such killing must be reported in writing to the commission; hides of beavers so killed are the property of the person killing them; other fur animals damaging property may be killed under permit of State game warden, but skins of animals so taken must be delivered to the State game commission for disposition.

PENNSYLVANIA

Open seasons: [1]	*Dates inclusive*
Bear [2] (over 1 year old)	Nov. 10–Dec. 15.
Raccoon	Oct. 1–Jan. 15.
Muskrat, skunk, mink, otter, opossum	Nov. 1–Feb. 28.
Fox, wildcat, weasel	Unprotected.[3]
Beaver	No open season.

Prohibited methods: Unlawful to take bears with steel trap, deadfall, or pen, or to shoot them except with a single bullet, but the use of steel-jacketed bullets is prohibited. Steel traps having a spread of jaws greater than 6½ inches may not be used for trapping fur animals or vermin. All traps must bear metal tag showing name and address of owner, must be visited once in every 36 hours, and at end of open season must be taken up or sprung. Unlawful to dig out fur animals; to drive them from holes or dens by use of smoke, explosives, or chemicals; to cut den trees; or to take fur animals by use of poison. Beaver houses and dams are protected, except under special permit. Unlawful to disturb traps of another or to remove fur animals therefrom.

Bag limits: One bear a season, or four to a camp or body of men.

Licenses: Nonresident, $15; issued by commission or county treasurer. Resident, $1.25 (fee of 15 cents extra to justice of peace); issued by county treasurer. Minors under 16 years of age may trap fur animals and vermin without a license. Licensee required to wear tag on middle of back. Resident citizen, members of family, and regularly hired help, residing on and cultivating land may hunt on such land, and, with consent of owner, on adjoining land without a license, during open season. Alien not permitted to hunt or kill any wild animal in State, except in defense of person or property. Trapper must report to board of game commissioners number of each kind of fur animals killed. Fur dealer, $1.

Possession and sale: Bear may be possessed only during open season and first 30 days of close season. Bear and raccoon skins taken during open season may be possessed or sold at any time. Raw skins may be possessed during the open season and the first 15 days of close season.

Shipment and export: Raccoons legally taken may be shipped or exported at any time. Packages must be plainly marked to show contents, name and address of owner, and county in which taken. Shipment by parcel post prohibited. Nonresident licensee may take out one bear legally killed. No other restrictions on skins legally taken and possessed.

Propagation: No restrictions on raising fur animals, except that possession and breeding of ferrets is unlawful except under license from State board of game commissioners; fee for license to breed and sell ferrets, $25; to possess a ferret without breeding, $1.

PENNSYLVANIA—Continued

Bounties: Wild cat, $15; gray fox, $4; red fox, $2; weasel, $1. Affidavit on form supplied by game commission must accompany entire unmutilated skin of animal when presenting claim to board of game commissioners, at Harrisburg, Pa.

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[1] *Pennsylvania:* Fur animals may be killed or captured alive by landowners or tenants and their employees at any time to protect their growing crops.

[2] Bears may be killed at any time in defense of person or property.

[3] Under permit (no fee) from board, dogs may be used in hunting foxes and wildcats, Dec. 16–Mar. 15.

PORTO RICO

Porto Rico has no wild fur animals.

RHODE ISLAND

Open seasons:[1]	*Dates inclusive*
Skunk	Nov. 1–Apr. 15.
Raccoon	Oct. 1–Feb. 1.
Muskrat, mink, otter	Nov. 1–Feb. 1.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to set wire snares, or to use steel traps with teeth or with spread over 6 inches, or choke traps with greater openings than 6 inches. Traps must be concealed so as not to endanger domestic animals and must be visited at least once every 24 hours.

Licenses: Hunting license required for trapping: Resident, $1.25; nonresident, $10.25; alien, $15.25; issued by town and city clerks. License not required of resident or his immediate family to hunt or trap on agricultural lands on which actually domiciled; nonresident owning real estate valued at not less than $500, and nonresident member of club incorporated for hunting or fishing purposes prior to January 1, 1909, which owns real estate assessed for taxation at value of not less than $1,000, may procure license at a fee of $1.25; nonresident guest of incorporated fox hunting club, $1.25 (authorizes fox hunting and is good for a period of 6 days); licenses not issued to minors under 15 years of age. Written permission required to trap on inclosed lands of another.

Possession and sale: No restrictions on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No legislation.

Bounties: Fox, $5; crow and certain hawks and owls, 25 cents; paid by State.

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[1] *Rhode Island:* Landowner may kill fur animals on own land at any time.

SOUTH CAROLINA

Open seasons:	*Dates inclusive*
Bear, mink, muskrat, otter, skunk, raccoon,[1] opossum, fox,[2] and other fur animals	Nov. 26–Mar. 1.[3]

Prohibited methods: Hunting at night prohibited except for raccoon, opossum, or fox. Unlawful to shoot or trap foxes, to dig them out of the ground, or to push or drag them out of a tree or log. Use of deadfall traps prohibited.

Licenses: Hunting license required: Resident, county license, $1.10; State, $3.10; issued by county clerk or game warden; nonresident, $15.25; issued by county clerk. No license required of resident owners, tenants, their children, or, under written permission, their employees to hunt during open season on own lands. Consent of owner or manager required to hunt or trap on lands of another.

Possession and sale: No restrictions on skins of fur animals legally taken.

SOUTH CAROLINA—Continued

Shipment and export: Skins of fur animals must be tagged by State warden or deputy before being shipped or transported. Tag fees: Otter, red fox, $1; raccoon, gray fox, mink, 25 cents; skunk, 10 cents; opossum, muskrat, 5 cents. Packages containing furs for transportation must bear certificate of State warden or deputy that the tag required to be attached to each pelt has been properly attached and paid for. Persons, firms, or corporations shipping furs must make monthly report to county game warden of number of skins shipped or transported. Shipments must be labeled to show the number and kind of skins in the package and the consignor and consignee. No other restrictions on skins of fur animals legally taken.

Propagation: No legislation.

Bounties: None paid.

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[1] *South Carolina:* Raccoons may be killed after July 15 by the owners of crops which they are destroying.

[2] Foxes doing damage may be shot on one's own premises at any time. Trapping foxes prohibited.

[3] Hunting season for raccoon, opossum, and fox, Sept. 1–Mar. 1. Wildcats may be killed without license at any time by officers of the law and by landowners upon their own holdings.

SOUTH DAKOTA

Open seasons:	*Dates inclusive*
Mink, muskrat (see exception), skunk, raccoon, opossum (season opens at noon and closes at noon)	Dec. 1–Feb. 1.
Exception: Muskrat, east of Missouri River	Dec. 1, 1927.
Beaver,[1] otter, silver, black, or cross fox	No open season.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to shoot or spear muskrats, or to destroy or molest muskrat houses, except that these may be opened without injury thereto for the purpose of placing traps therein during open season. No person may set or operate more than 75 traps at any one time.

Licenses: Resident, $5; nonresident, $25; issued by State secretary of agriculture and county treasurer. License not required of residents under 14 years of age, nor of landowners trapping on own lands during open season. Unlawful to hunt on cultivated or posted lands of another without permission of owner.

Possession and sale: Beaver skin must bear metal tag (fee, 50 cents) from State secretary of agriculture. Unlawful to possess, buy, or sell raw skins of protected fur animals during close season, whether taken or killed within or without the State.

Shipment and export: Permit from State secretary of agriculture required to sell or ship beaver skins, unlawful to ship raw skins of protected fur animals during close season, whether taken or killed within or without the State.

Propagation: Breeder's permit required to conduct a fur farm; fees, $1 for each silver, black, or cross fox, and $1 for each other kind of fur animal.

Bounties: None paid by State. A county may pay $50 for each grown wolf, $4 for each wolf (other than coyote or prairie wolf) less than 1 year old, $10 for each mountain lion, and $4 each for coyote or prairie wolf, fox, lynx, and bobcat.

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[1] *South Dakota:* Skunks and minks doing damage around buildings may be killed at any time, and, under permit from State secretary of agriculture, muskrats or beavers damaging irrigation ditches, embankments, or public highways may be taken at any time.

TENNESSEE

Open seasons:[1]	*Dates inclusive*
All fur animals (season opens at noon and closes at noon) (see exceptions)	Nov. 15–Feb. 15.[2]
Exceptions: Beaver, muskrat, fox, mink, raccoon, skunk, opossum:	
In Davidson, Robertson, and Shelby Counties	Sept. 1–Jan. 31.[2]
In Franklin County	Nov. 1–Jan. 31.[2]
All fur animals in Dyer and Henderson Counties	No open season.

Prohibited methods: Steel traps must be placed at least 12 inches within the entrance to a hole, cave, den, or hollow log. Use of snares and deadfalls prohibited.

Licenses: None required. Written consent required to trap on lands of another. Traps must be inspected within each 36 hours, and captured animals removed; does not apply to trapping wildcats in Lauderdale County.

Possession and sale: No restrictions, except locally. In Davidson, Franklin, Robertson, and Shelby Counties the sale of protected fur animals is prohibited during close season.

Shipment and export: No restrictions except locally. In Davidson, Franklin, Robertson, and Shelby Counties it is unlawful to remove any protected fur animal from county during close season.

Propagation: No legislation.

Bounties: Wolf or panther, $2 certificate issued by county court, the amount to be applied on payment of taxes.

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[1] *Tennessee:* Trapping on State property, including lakes, prohibited.

[2] Fur animals may be taken on one's own land at any time.

TEXAS

Open seasons:	*Dates inclusive*
Bear	Nov. 16–Dec. 31.
Beaver, otter, fox	No open season.
Muskrat	Nov. 16–Mar. 14.
Other fur animals	Dec. 1–Feb. 14.

Prohibited methods: Beds, nests, and breeding places of muskrats protected, and muskrats may only be taken by trapping, except on own land, where they may be taken at any time by any means. Headlight, hunting-lamp, or other artificial light prohibited.

Bag limits: One bear a season.

Licenses: Resident, $1; nonresident or alien, $50. License not required of resident owners, tenants, and their children on own land. Consent of owner necessary to trap on inclosed land of another.

Possession and sale: Muskrat skins taken on lands of another may not be purchased on such lands except from the landowner or his authorized agent. Possession of beaver, otter, or fox skins for sale prohibited. No other restrictions on skins legally taken.

Shipment and export: No restrictions on skins, legally taken.

Propagation: Permit must be obtained from game, fish, and oyster commissioner to trap or transport wild animals for propagation.

Bounties: None paid.

UTAH

Open seasons:[1]	*Dates inclusive*
Bear	Sept. 1–May 1.[2]
Beaver,[3] otter	No open season.
Mink, muskrat,[4] marten, raccoon	Nov. 15–Dec. 15. Feb. 15–Mar. 15.
Other fur and predatory animals	Unprotected.

Prohibited methods: Use of silencer on gun and discharge of firearm from automobile or within 50 feet of a public highway prohibited. Traps may not be placed within 25 feet of muskrat house or den.

UTAH—Continued

Licenses: Resident citizen, $5. Issued by State fish and game commissioner or deputy, county clerk, or deputy or authorized agent. Not issued to minors under 16. Unlawful to disturb or remove traps of licensed trappers on public domain or on lands where they have permission to trap. Aliens other than homesteaders are not permitted to hunt or trap.

Possession and sale: Skins of fur animals legally taken may be possessed and sold at any time, except that the skins of beavers, which may be taken only when doing actual damage to property under permit of the commissioner, must be turned over to the commissioner to be sold by him. Possession of beaver skins prohibited, except by a permit holder, unless tagged by commissioner. Green pelt or carcass of fur animal may not be possessed except during open season and 15 days thereafter.

Shipment and export: Shipment and export of furs legally taken and possessed permitted at any time.[3] (*See* "Possession and sale.") Skins of beavers taken under permit of the commissioner may only be shipped by the permittee to the commissioner for sale. Shipment or export of beaver skins prohibited, unless such skins are tagged by the commissioner.

Miscellaneous: Use of the flesh of game animals or birds as trap bait for fur animals prohibited.

Propagation: Permit (no fee) from commissioner required to propagate fur animals, but such animals held under permit may not be killed during close season.

Bounties: Wolf, $62.50; bear, mountain lion, cougar, $30; coyote, $4; lynx, bobcat, $3.

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[1] *Utah:* Commissioner may shorten or close season on fur animals, or further restrict the number which may be taken, where necessary to afford sufficient protection to any species.

[2] Dogs may be used in pursuit of bear, and bear destroying livestock may be killed at any time by cattle owners or their employees or Federal or State trappers.

[3] When beavers are destroying property, the State fish and game commissioner may grant permit to trap them, but the hides of animals so taken must be delivered to and sold by commissioner, who shall recompense for trapping in not more than half of the proceeds from sales.

[4] Property owner may trap muskrats doing actual damage to dams, ditches, or watercourses in sufficient numbers to insure protection to such property.

VERMONT

Open seasons:[1]	*Dates inclusive*
Muskrat (see exception)	Oct. 25–Apr. 15.
Exception: On shores of Lake Champlain in Rutland County, Poultney River below Carver Falls, and shores of Lake Memphremagog in Orleans County	Jan. 1–Apr. 30.
Mink, otter, marten, fisher, skunk (see exception)	Oct. 25–Feb. 15.
Exception: Mink and otter on shores of Lake Champlain in Rutland County, Poultney River below Carver Falls, and shores of Lake Memphremagog in Orleans County	Jan. 1–Apr. 30.
Raccoon, fox	Oct. 15–Feb. 15.
Beaver	No open season.

Prohibited methods: The use of set guns, snares, and poisons is prohibited; bear traps must be carefully safeguarded and visited once in 48 hours. Unlawful to open or destroy a muskrat house or to place a trap at its entrance. Unlawful to dig skunks from dens or to drive them out by use of smoke or chemicals, or to dig out fox dens during close season.

VERMONT—Continued

Licenses: Resident, $1; nonresident, $10.50; issued by town clerk. Owners of farm lands and their resident minor children or tenants may take fur animals on own lands during open season without a license. License not issued to persons under 16 years of age without written consent of parents or guardians. Nonresident citizen owning improved real estate appraised at not less than $1,000, upon which he pays taxes, may obtain a resident license. Persons trapping on inclosed lands of another must, within 12 hours, inform owner of location and number of traps and must visit traps at least once in 24 hours.

Possession and sale: Possession of fur animals during close season prohibited, but the fur or skins of animals legally taken may be possessed, bought, or sold at any time.

Shipment and export: Packages containing fur animals or parts thereof delivered to a common carrier for transportation must be tagged to show the number and kind of such animals or skins therein, names of consignor and consignee, station from which shipped, and destination. A person required to have a license must also show the number of his license on the shipping tag. No other restrictions on skins legally taken and possessed.

Propagation: The State fish and game commissioner issues special permits for propagating fur and game animals (fee, $2 and expense of tagging). Animals bred on fur farms may be sold and transported alive at all times when bearing the identification tags prescribed by the commissioner.

Bounties: Towns pay $8 bounty on bay lynx or bobcat and $1 on rattlesnake.

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[1] *Vermont:* Fur animals may be killed at any time to protect one's own property.

VIRGINIA

Open seasons:	*Dates inclusive*
All fur animals (see local laws)	Dec. 1–Mar. 31.[1]
Albemarle, Amherst, Madison, Nelson, Orange, and Spotsylvania Counties:	
Fox (trap)	Nov. 1–Nov. 30.[2]
Charles City, Essex, James City, New Kent, Warwick, and York Counties:	
Muskrat	Dec. 15–Mar. 31.
Jefferson magisterial district—in Culpeper County:	
Fox (trap)	Nov. 1–Dec. 31.
Fauquier and Loudoun Counties: Fox	Sept. 1–Mar. 31.[3]
Henry, Pittsylvania, and Tazewell Counties: Fox	Spet. 15–Mar. 15.
Patrick County:	
Raccoon, opossum	Oct. 15–Mar. 14.
Gray fox	Sept. 15–Mar. 14.
Princess Anne County:	
Mink, muskrat, otter (for profit)	Nov. 1–Mar. 14.

Prohibited methods: Unlawful to take muskrats in tidewater sections of State from one-half hour after sunset to one-half hour before sunrise, except by traps.

Licenses: Hunting license required to trap: Nonresident, $10; alien, $20 (alien owner of real estate resident for five years, same as resident). Resident: State, $3; county of residence, $1. Issued by clerks of circuit and corporation courts. License not required of residents to hunt foxes with hounds. Residents and nonresidents and their children may hunt on own land during open season without a license. Tenant, under written consent of owner or landlord, may hunt without license during open season on lands on which he resides. Written permission is required to trap or hunt on lands of another.

Possession and sale: No restrictions on skins legally taken, except that sale of red or gray fox is prohibited during close season in Henry County.

Shipment and export: No restrictions on skins legally taken.

VIRGINIA—Continued

Propagation: License required (fee, $25) to raise game or fur animals.

Bounties: Weasel, $1; sharp-shinned and Cooper hawk, goshawk, great-horned owl, 50 cents each; crow (if killed April 1–September 30), 15 cents each; paid by county clerk.

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[1] *Virginia:* Season applies to trapping on lands of another, which is lawful only with written permission of owner, which permission the trapper must have on his person when trapping. Landowner may trap or kill fur animals on his own land at any time.

[2] Unlawful to shoot a fox in Albemarle, Madison, Nelson, Orange, or Spotsylvania County.

[3] Foxes may be taken at any time by owner or tenant of land to protect property in Fauquier and Loudoun Counties. Written permission of owner required to take foxes on lands of another.

WASHINGTON

Open seasons:	
Beaver	No open season.
Bear and other fur animals (open season fixed by county game commissions).[1] [2]	

Prohibited methods: No steel trap larger than No. 4 may be used unless a notice in the English language on a large placard is placed above the trap.

Licenses: County, $5; issued by county auditor. License not required of landowners and leaseholders trapping on own premises, nor of minors under 16 years of age.

Possession and sale: Carcass and pelt of bear lawfully taken may be sold at any time; beaver skins secured without the State, if inspected and tagged (tag, 10 cents) by supervisor of game and game fish, may be possessed or sold at any time. Other furs legally taken coming from without State may be possessed, sold, and transported, if reported to supervisor of game and game fish or county game commission, within three days after arrival, and tagged (tag, 10 cents).

Shipment and export: Carcass and pelt of bear and skins of other fur animals legally taken and possessed may be shipped at any time.

Propagation: Breeder's license (fee, $10; renewal, $5) required.

Bounties: Paid by State. Counties are permitted to pay bounties on mountain lion or cougar, lynx or wildcat, coyote, timber wolf, bear, muskrat, squirrel, and in the Columbia River district on seal or sea lion. Hair seal, $3 (paid by State).

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[1] *Washington:* Communicate with county game commission at county seat, or supervisor of game and game fish, Box 384, Seattle. Bears may be killed at any time when destroying domestic animals.

[2] Under written permission from county game commission or supervisor of game and game fish, landowners and leaseholders may trap muskrats and moles doing damage to property.

WEST VIRGINIA

Open seasons:[1]	*Dates inclusive*
Skunk	Dec. 1–Jan. 31.
Red fox, in Brooke, Cabell, Fayette, Harrison, Kanawha, Lewis, Mason, Mingo, Morgan, Pleasants, Putnam, Ritchie, Summers, Taylor, Upshur, Wetzel, Wirt, Wood, and Wyoming Counties	Dec. 1–Jan. 31.
In rest of State	Unprotected.
Raccoon, opossum	Nov. 1–Jan. 31.
Beaver, otter	No open season.[3]
Muskrat	Nov. 1–Feb. 28.
Other fur animals	Unprotected.

WEST VIRGINIA—Continued

Prohibited methods: Unlawful to set a steel or spring bear trap on land of another. Unlawful to hunt wild animals, except those which take refuge in trees, with a spot or jack light or other artificial light, or to cut down any tree in which animals den or take refuge for the purpose of capturing such animals.

Licenses: Hunting license required to take raccoons, opossums, beavers, otters, and skunks: Resident, $1; nonresident, $15; issued by county clerk. Resident landowner, his resident children, or tenants, may hunt or trap during open season on own land without a license. License not required of minors under 15 years of age. Express permission of owner or tenant required to set or maintain a snare or trap upon land of another. Licensee must wear tag.

Possession and sale: No restriction on skins legally taken.

Shipment and export: No restrictions on skins legally taken.

Propagation: No restriction on possession or sale, but animals must not be taken for breeding purposes in close season except on lands owned or tenanted by the breeder.

Bounties: Wildcat, bobcat, or catamount, $5; crow, 10 cents; certain hawks and owls, 25 cents; paid from forest, game, and fish protection fund.

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[1] *West Virginia:* A landowner, his agent, or tenant may hunt or kill fur animals on his own lands at any time.

[2] Commission may open season on beaver and otter.

WISCONSIN

Open seasons:	*Dates inclusive.*
Beaver,[1] marten, fisher	No open season.
Otter in Florence, Forest, Iron, Juneau, Price, Langlade, Oconto, Oneida, and Vilas Counties	Mar. 1–Mar. 31.
In rest of State	No open season.
Mink, muskrat [1] (see exceptions)	Jan. 1–Apr. 10.
Exceptions in Calumet, Florence, Fond du lac, Forest, Green Lake, Langlade, Lincoln, Marathon, Marinette, Marquette, Oneida, Outagamie, Shawano, Waupaca, Waushara, and Winnebago Counties	Oct. 25–Apr. 1.
In Crawford, Richland, and Vernon Counties	No open season.
Skunk, raccoon in all counties south of north line of Buffalo, Trempealeau, Jackson, Wood, Portage, Waupaca, Outagamie, Brown, and Kewaunee Counties	Nov. 1–Jan. 31.
In rest of State	Oct. 15–Jan. 15.
Black bear and other fur animals	No close season.

Prohibited methods: Unlawful to take fur animals with the aid of spear, gun, or dog; to disturb or molest muskrat houses, beaver houses, or beaver dams, or to molest or disturb raccoon den trees.

Licenses: Resident, $1, issued by conservation commission. Each trap must be tagged, fee, 5 cents. Report required from licensed trapper on or before June 1 of each year. Nonresident not permitted to trap; alien not permitted to hunt. Written consent of owner or occupant required to trap minks or muskrats on agricultural lands of another.

Possession and sale: Possession of green skins of fur animals permitted only during open season and first five days of close season; possession prohibited of the skin of a mink or muskrat which shows that the animal has been shot or speared. No other restrictions on possession and sale of skins legally taken.

Shipment and export: Shipment of hides must be marked to show the number and kinds of hides, the name and address of the shipper, and the number of his trapping license.

WISCONSIN—Continued

Propagation: Under license and supervision of the commissioner, beaver, muskrat, or skunk may be taken and transported for propagation within the State. Special license required for beaver farming (fee, $2.50, and 25 cents an acre for all land in excess of 10 acres). Special license required for muskrat or skunk farming (fee, $2.50, and 15 cents an acre for all premises in excess of 10 acres covered by the license). Breeders have same rights in silver, silver-black, and black foxes as domestic animals. Unlawful to trespass on posted fox farm.

Bounties: Wolf cub taken between March 1 and November 1, $4; mature wolf killed at any time, $30; fox, $2; paid by State. County boards may offer bounty on crow, hen hawk, pocket gopher, streaked gopher, groundhog or woodchuck, English sparrow, blackbird, or rattlesnake.

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[1] *Wisconsin:* If beavers damage property, they may be captured and removed under permit and the direction of the State conservation commission; skins of animals that are killed in taking must be delivered to the conservation commission. Owners or lessees of dams, under permit of conservation commission, may destroy at any time muskrats to protect such dams or levees, but they may not sell, barter, or give away the skins of such animals killed during close season.

WYOMING

Open seasons:	*Dates inclusive.*
Beaver	No close season.[1]
Otter, fisher, marten, mink, muskrat (see exception), fox, raccoon	Nov. 16–Mar. 31.
Exception: Muskrat in Big Horn, Campbell, Converse, Fremont, Platte, Sheridan, and Uinta Counties	No close season.
All other animals	Unprotected.

Prohibited methods: Unlawful to trap bears.

Licenses: Resident citizen, $10; nonresident citizen, $50. License not required of persons under 17 years of age. Permit for trapping in State game preserves, fee, $5; for trapping in national forests, $5; issued by State game and fish commissioner. Employees of the Federal Government do not require permit to trap predatory animals. For bear: Resident (hunting license), $2.50; nonresident, $25; limit, 3 bears; issued by commissioner. Nonresident may take 3 bears, not more than one of which may be a grizzly, Sept. 1–June 15, under big game license. The killing of a bear must be reported not later than December to the commissioner. Dog license, $1 (required for each dog used in hunting predatory animals in national forests). Permission of owner required to hunt or trap on inclosed lands of another.

Possession and sale: Skins of beavers killed when doing damage to real estate may be possessed when duly tagged by commissioner and affidavit is furnished the commissioner by the owner of the real estate showing the damage and number of beavers killed, and upon the payment of 50 cents for each beaver tag.

Shipment and export: Beaver hides must be tagged by commissioner before being shipped or transported.

Miscellaneous: Use of the flesh of game animals or birds as trap bait for predatory animals prohibited.

Propagation: Beavers may be taken for propagation under a $5 permit, but animals so taken must be kept three years before being killed or sold.

Bounties: None paid by State.

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[1] *Wyoming:* Close season on beavers expires Mar. 15, 1927. If beavers damage real estate the owner thereof may kill them from Mar. 1 to May 31, but must furnish State game and fish commissioner with affidavit showing damage and number killed. Skins of animals so taken must be tagged immediately (fee, 50 cents each).

LAWS OF CANADA

ALBERTA

Open seasons:[1]	*Dates inclusive*
Mink, fisher, marten, fox[2]	Nov. 1–Mar. 31.[3]
Otter	Nov. 1–Apr. 30.
Muskrat (see exception)	Mar. 1–Apr. 30.
Exception: South of North Saskatchewan River	No open season.[4]
Beaver[3]	Dec. 31, 1925.[4]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to use poison for taking fur animals; or to destroy, partially destroy, or to leave open any muskrat or beaver house or beaver dam.

Licenses: Trapping: Resident, $2; nonresident, $25; issued by minister of agriculture. License not required of farmer, or member of his family while actually residing with him upon his farm. Consent of owner or occupant required to trap on inclosed or cultivated lands of another. Permits to trap on game or forest reserves may be granted under regulations of the lieutenant governor in council. *Taxidermist:* $5. *Dealer* in furs and skins of protected animals at a specified place of business, or within one mile thereof: Resident of a city, $25; resident outside of a city, $10; nonresident, $100. Traveling license issued to holder of a dealer's license or his manager upon payment of fee of $15. Traveling buyer: Resident, $25; nonresident, $100. Nonresident buying wholesale from licensed dealers, $5 (good for 10 days only). Licensee must make semiannual reports to department of agriculture. License to sell skins by tender or auction, fee, $25. Issued by minister or agents.

Possession and sale: No restrictions on prime skins legally taken and possessed.

Shipment and export: Export of furs and skins prohibited except under permit from minister. No furs or skins on which royalty has not been paid may be exported, and a special permit from the minister is necessary to ship out unprime skins. Export of live wild foxes prohibited.

Propagation: Manager of fur farm required to make reports January 1 and July 1 of each year. Export of live animals from fur farms allowed only on permit from the minister of agriculture. Permit, with fees, required to export live muskrat, mink, fisher, marten, otter, or beaver, whether raised on a fur farm or otherwise (orders in council).

Bounties: The council of any rural municipality is authorized to offer a bounty on wolf.

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[1] *Alberta:* Lieutenant governor in council may change close seasons on fur animals.

[2] Unlawful to trap fox for export.

[3] Unlawful to destroy a beaver dam unless authorized to do so by the lieutenant governor in council, who may also authorize the killing of beavers or other fur animals when such killing is deemed to be in the public interest.

[4] Lieutenant governor in council may declare open seasons locally on beaver and muskrat.

BRITISH COLUMBIA

Open seasons:[1, 2]	*Dates inclusive*
Bear (except white or Kermodei bear) in northern district	Sept. 1–June 30.
In eastern district	Sept. 15–June 30.
In western district (except Vancouver Island, Nov. 1–May 31)	Sept. 1–June 15.
All fur animals in northern district	Nov. 15–Apr. 30.
In eastern district (see exception)	Nov. 15–Apr. 30.
Exception: Beaver, muskrat, south 53d parallel	No open season.
In western district (see exceptions)	Dec. 1–Mar. 31.
Exceptions: Muskrat on Vancouver Island	No open season.
Beaver in Prince Rupert, Skeena, and Mackenzie electoral districts	Dec. 1–Mar. 31.
In rest of district	No open season

BRITISH COLUMBIA—Continued

Prohibited methods: Bear may not be trapped. Unlawful to use poison in taking fur animals, except that farmers and poultrymen may protect own stock; to destroy muskrat or beaver houses, except under permit to prevent damage on dyked or agricultural lands; or to hunt fur animals at night.

Bag limits: Three bears of any species (except 2 grizzly bears in northern district and 1 grizzly in eastern and western districts).

Licenses: *Trapping:* Resident, British subject, $10; nonresident or resident alien not permitted to trap; nonresident special license to hunt—not trap—bears from January 1 to July 1, $25; nonresident general hunting license, fee, $25, and additional fees of $15 to $25 for each bear killed. License not issued to boys under 18 years of age without written consent of parent or guardian. Issued by provincial game warden or authorized agent. Licensee must wear badge. Permission of owner required to trap on inclosed, cleared, or cultivated land of another. A licensed trapper who first occupies a trap line not later than 15 days after the beginning of any open season for trapping is protected against other trappers. Unlawful to touch or interfere with traps set by a licensed trapper. License must be returned within two months after it expires, with a statement of number of fur animals of each kind taken. *Fur dealer:* Resident, $25 (does not apply to licensed trapper selling skins taken by himself); nonresident or his agent, $200. License required for each place of business. Fur dealer must make verified report every three months, showing number and kind of skins purchased and date of transactions. *Taxidermist:* $5. *Tanner:* $5. Game conservation board may grant permit (fee, $25) to buy furs at wholesale from licensed fur dealers or at public auction.

Possession and sale: Unlawful to sell pelts taken during close season or to possess unprime furs. Possession of pelts of fur animals allowed only during open season and for two months thereafter (three months, north of 52d parallel), except under special permit from game conservation board. Unlawful for fur trader to possess skins on which royalty has not been paid. Does not apply to skins taken by a licensed trapper if sold to a licensed resident dealer nor to skins of animals raised in captivity. Bears may be sold only during respective open seasons in northern and eastern districts.

Shipment and export: Export of pelts of fur animals allowed only under special permit of game conservation board. Packages must be prepared so that they may be easily opened for examination, or labeled with a full description of the contents, and names and addresses of the consignor and consignee, and accompanied by export permit.

Propagation: A permit from the game conservation board is required to propagate fur-bearing animals or to take them for breeding purposes. Breeder must keep a record of transactions as to purchases and sale of stock, which record must be open to inspection of any game warden, and must make verified report to game conservation board on or before August 31. Live animals and birds may be exported only under permit; and a permit is required to take foxes or other fur animals in close season.

Bounties: Panther, $40; timber wolf, $25; coyote $2 (if not less than one week old). (Rates fixed from time to time by lieutenant governor in council.)

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[1] *British Columbia:* Seasons on fur animals fixed annually by lieutenant governor in council.

[2] *Northern district* includes electoral district of Atlin and that portion of Province north of main line Canadian National Railway and east of Cascades. *Eastern district* includes that portion of Province lying east of the summit of the Cascades and south Canadian National Railway. *Western district* includes that portion of the Province not included in the northern and eastern districts, namely, west of the summit of the Cascades and south of Atlin electoral district.

MANITOBA

Open seasons:[1]	*Dates inclusive*
North of fifty-third parallel—	
Fisher, pekan, sable, marten, mink	Nov. 1–Mar. 31.
Otter, beaver	Nov. 1–Apr. 30.
Muskrat	Mar. 15–May 15.
Fox, lynx	Nov. 1–Feb. 28.
South of fifty-third parallel—	
Fisher, pekan, sable, marten mink	Nov. 1–Mar. 31.
Otter, beaver[2]	No open season.
Muskrat	Mar. 15–Apr. 30.
Fox, lynx	Unprotected.

Prohibited methods: Use of poison or dog in taking or hunting fur animals is prohibited. Unlawful to shoot or spear muskrats or to destroy muskrat houses. Beaver houses and dams protected, except under permit to protect property.

Licenses: *Trapping;* Resident, $2; nonresident Canadian citizen, $50; nonresident alien, $200; issued by minister of agriculture and immigration. Permission of owner required to trap on cultivated or inclosed lands of another. Licensee must return his license and make a report during the month of June, showing the number of each kind of animals taken. *Fur trading:* Nonresident trader, $50; traveling fur buyer, $25; resident raw fur merchant or dealer, $10; resident traveling agent, $10; issued by minister. Licensees are required to keep record and to make monthly reports of furs handled. *Fur dressing and tanning:* $10; issued by minister. Licensee must keep records and report to the chief game guardian on or before the 10th of each month the number of royalty pelts handled and the name and address of person forwarding or delivering the skins.

Possession and sale: Possession of unprime skins prohibited. Unlawful to purchase or sell the skins of muskrats that have been speared or shot. Any person purchasing or acquiring pelts from a trapper must ascertain that he holds proper trapping permit and at the same time record his name and the number of his permit. Unlawful to purchase, barter, or trade the pelt of a fur animal taken during the close season (does not apply to imported skins). No other restrictions on skins legally taken.

Shipment and export: Export prohibited of unprime skins or skins on which royalty is payable unless such skins have coupons attached to show royalty paid; each shipment must be accompanied by a permit procured from minister upon surrender of counterpart of royalty coupon, and have attached a declaration of the number and kinds of skins contained, and also set forth that counterfoils of royalty coupons are attached as required. Shipment or removal from Province prohibited except by express or mail. No other restrictions on skins legally taken. Export prohibited of live protected animals (except ranch-bred animals) except under permit from minister of agriculture and immigration (permit must accompany shipment to destination); fees, for black or silver fox, $100; for other fox, $15; for otter, $25; for beaver, $5; for mink, fisher, or marten, $1; for muskrats, $2 a dozen or fraction thereof.

Propagation: License (fee, $5) must be obtained from the minister to operate a fur farm. Licensee, on or before the first days of January and July, must make verified reports showing the number, species, age, and sex of the animals on hand, from whom procured, and the number which have died during previous six months, with cause of death.

Bounties: Timber wolf,[3] $5; other wolf,[3] $2; half is refunded to municipality by provincial treasurer.

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[1] *Manitoba:* The lieutenant governor in council may shorten the current open season on fur animals. Trapping in provincial game preservse prohibited.

[2] Game commissioner may take necessary steps to prevent beaver damage, but no beaver dams may be disturbed between October 1 and April 1.

[3] Poison may not be used to capture wolves for bounty.

NEW BRUNSWICK

Open seasons:	*Dates inclusive*
Mink, otter, fisher, marten, sable	Nov. 1–Mar. 31.
Fox	Oct. 1–Feb. 28.
Muskrat (see exception)	Mar. 25–May 1.
Exception: In Carleton, Gloucester, Kent, Madawaska, Northumberland, Restigouche, and Victoria Counties	Mar. 25–May 25.
Beaver	No open season.[1]
Other fur animals	Unprotected.

Prohibited methods: Unlawful to take fur animals by use of poisons, with aid of hounds, or with gun equipped with silencer; to dig out foxes from their homes or earth burrows; or to shoot muskrats.

Licenses: *Trappers and fur dealers:*[2] Persons domiciled in Province, $10; all other persons, $50. Trappers and fur dealers must furnish the minister with written declarations showing their names and addresses, the location of warehouses, shops, posts, or caches where skins are to be stored and the places from which the skins will be shipped out of the Province, and must make monthly reports of operations. Issued by minister of lands and mines. License is required to traffic in, cure, or tan skins: Resident, $10; nonresident or resident alien, $50; issued by minister. Special license (accompanied by necessary tags) to trap beavers at designated times may be issued by minister; fee, $5 for each animal.

Possession and sale: Possession prohibited of furs on which royalties, as fixed by lieutenant governor in council, have not been paid; possession of green skins or carcasses of protected fur animals in close season prohibited.

Shipment and export: Skins legally taken, possessed, tagged, and on which the royalty has been paid, may be exported under permit from minister. Permit from minister required to export live fur animals.

Propagation: Permits to capture wild fur animals for propagation within the Province may be obtained from the minister, who fixes the fee for such permit.

Bounties: Wildcat, $3.

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[1] *New Brunswick:* Expires November 1, 1927.

[2] License requirements and other provisions of act do not apply to hunter or trapper who is a British subject domiciled and residing in Province, who actually hunts, provided he sells his furs to a person domiciled in the Province.

NORTHWEST TERRITORIES[1]

Open seasons:[2]	*Dates inclusive*
Mink, fisher, marten	Nov. 1–Mar. 14.
Otter, beaver, muskrat (see exception)	Oct. 1–May 14.
Exception: Muskrat, north of latitude 64°	Oct. 1–June 14.
Foxes	Nov. 15–Mar. 31.

Prohibited methods: Unlawful to use poison in taking fur animals or to destroy or injure any muskrat house or beaver dam or house.

Licenses: *Trapping:* Resident, $2; nonresident, British subject, $75; other nonresident, $150. *Fur dealer and trader or trafficker in furs:* Resident, $5; nonresident British subject, $150; nonresident not British subject, $300. Issued by director of Northwest Territories. License not required of native-born resident Indian, Eskimo, or half-breed. On or before July 1, licensed trapper must report to nearest game officer number of fur animals taken under license.

Possession and sale: Licensed trapper may sell or trade the skins of animals he has legally taken. Possession of unprime or low-grade furs prohibited. No restrictions on other skins legally taken.

Shipment and export: No restrictions on skins legally taken and possessed.

NORTHWEST TERRITORIES—Contd.

Propagation: Permits may be obtained to take fur animals for propagation.

Bounties: Timber wolf, $30 (skin must be surrendered).

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[1] *Northwest Territories* means the northwest territories formerly known as Rupert's Land and the Northwestern Territory (except such portions thereof as are included in the Provinces of Ontario, Quebec, Manitoba, Saskatchewan, and Alberta, and the Yukon Territory), together with all British territories and possessions in North America and all islands adjacent thereto not included within any Province, except the Colony of Newfoundland and its dependencies.

[2] Trapping prohibited on Victoria and Banks Islands and in Peel River, Yellowknife, Slave River, and Backs River Preserves, which have been reserved as hunting and trapping grounds for native Indians, Eskimos, and half-breeds.

NOVA SCOTIA

Open seasons:[1]	*Dates inclusive*
Beaver, marten, fisher	No open season.
Bear, wolf, wildcat	Unprotected.
Other fur animals	Nov. 1–Jan. 31.

Prohibited methods: Unlawful to take any protected fur animal (unless under a permit) from a burrow or den by smoking, digging, or otherwise; to take fur animal by use of poison; to damage or molest a beaver dam or house or a muskrat house or to set snare or trap within 25 feet of the latter.

Licenses: *Trapping:* None required of resident; nonresident, $50; issued by Provincial secretary, commissioner of forests and game, and municipal clerks. *Fur buyers:* Nonresident, $100; resident, $5; resident traveling buyer, $25; issued by commissioner. Fur buyer must keep record and make monthly report of number of skins bought or sold, together with names and addresses of parties from whom purchased or to whom sold. Royalties of varying amounts must be paid on all furs, except bear, wolf, and wildcat.

Possession and sale: Unlawful to possess or sell the green hide of any beaver, fisher, or marten, or to possess the green hide of any fur animal taken out of season. No other restrictions on skins legally taken.

Shipment and export: Unlawful to export skins of fur animals except under certificate of inspection and permit (fee, 50 cents) from a game inspector.

Propagation: Permits (fee, $1) to take wild animals may be obtained from the commissioner of forests and game under such restrictions as he may prescribe. Unlawful to keep fur-bearing animals in captivity for breeding porposes without a permit from the commissioner; fee, $2 for each kind of animal kept, payable annually. Reports are required annually on December 31. Unlawful to trespass in inclosures for fur animals.

Bounties: None paid.

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[1] *Nova Scotia:* Fox, raccoon, skunk, weasel, or muskrat may be killed on one's own inclosed premises for the protection of private property.

ONTARIO

Open seasons:[1]	*Dates inclusive*
Mink, fisher, marten, raccoon	Nov. 1–Mar. 31.
Muskrat (see exception)	Apr. 1–May 21.
Exception: South of French and Mattawa Rivers	Mar. 1–Apr. 21.
Beaver, otter (see exception)	Dec. 15–Mar. 31.[2]
Exception: South of French River, Lake Nipissing, and Mattawa River	Jan. 1, 1926.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to shoot or spear muskrat, to injure or destroy any muskrat or beaver house or beaver dam, or to set trap closer than 5 feet to a muskrat or beaver house.

ONTARIO—Continued

Licenses: *Trapping:* Resident, $5; nonresident, $50; issued by department of game and fisheries. License not required to take bear or wolf by any means, or fox by means of gun or dog. Nonresident not permitted to take beaver or otter. Farmers and their sons may trap on own land during open season without license, except that a license is necessary to trap beaver or otter thereon (fee, $5). Permission of owner required to trap beaver on lands of another. *Fur dealers or traders:* Resident British subject, $25 (store license), $100 (traveling fur buyer), $100 (wholesale license); resident, $1 (restricted—buying for personal use); alien or nonresident, $200; nonresident, $5 (buying from wholesalers); licensee must make reports monthly. *Fur dressing and tanning:* $10; licensee must keep records and make monthly reports.

Possession and sale: Possession of furs during close season prohibited except under permit. Possession and sale of unprime skins prohibited, except under permit. Unlawful for trapper or farmer to sell beaver or otter skins except to a licensed dealer. Unlawful to have skins dressed, plucked, or treated in any way except under permit obtained upon payment of royalties.

Shipment and export: Export prohibited except under permit obtained upon payment of royalties. No other restrictions on skins legally taken, possessed, or tagged. Shipments must be made by express or parcel post and packages must be marked with a list of the contents and the names and addresses of consignor and consignee.

Propagation: A permit is required of breeders of game or fur animals. Licensed fur breeders may sell live animals or skins during open season upon payment of royalties. The minister may grant permits to take fur animals for propagating purposes during the close season.

Bounties: Adult wolf, $15; wolf pups under 3 months old, $5; paid by county, but Provincial treasurer refunds 40 per cent to the county. Provincial treasurer pays entire bounty in unorganized counties.

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[1] *Ontario:* Fur animals may be destroyed in defense of property, but skins so taken may not be sold during close season except under permit from minister.

[2] Beaver and otter may be taken by residents only. Under special permit from minister, overseer or other officer may take or kill beaver doing damage to roads or private property.

PRINCE EDWARD ISLAND

Open seasons:	*Dates inclusive*
Otter, marten, mink, muskrat, skunk, raccoon	Nov. 1, 1927.
Beaver	No open season.[1]
Fox	Dec. 1–Jan. 31.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to put out poisoned baits for fox or other animals.

Licenses: *Trapping:* None required of resident; nonresident, $50; issued by secretary-treasurer of Province. The game warden may grant permits to take beaver and issue coupons (fee, $1 each) to tag skins of animals taken.

Possession and sale: Possession and sale during close season prohibited. Holders of permits may possess, buy, or sell beaver skins which have proper coupons attached.

Shipment and export: No restrictions on animals legally taken, possessed, and tagged.

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[1] *Prince Edward Island:* Beaver may be taken under special license. They may be destroyed by the owner of private property on which they are locating and building dams, and, under permits from game warden or lieutenant governor in council, their dams may be destroyed when necessary to prevent damage to property.

PRINCE EDWARD ISLAND—Continued

Propagation: Several special acts of provincial legislature regulate fox ranching on the island. The animals are assessed for taxation, ranches are protected from trespass under heavy penalties, and incomes from ranches are taxed.

Bounties: None paid.

QUEBEC

Open seasons:	*Dates inclusive.*
Bear	Aug. 20–June 30.
Muskrat (see exception)	Nov. 1–May 31.
Exception: South of 50th parallel	Mar. 15–Apr. 30.
Fox	Nov. 1–Feb. 28.
Beaver, otter	Dec. 15–Apr. 30.
Other fur animals	Nov. 1–Mar. 31.

Prohibited methods: Use of poisons in taking fur animals prohibited.

Licenses: *Fur dealers:* Persons domiciled in Province, $25; all other persons, $100; issued by minister of fisheries and game. Fur dealers must furnish the minister with written declarations showing their names and addresses, location of warehouses, shops, posts, or caches where skins are to be stored and the places from which such furs will be shipped out of the Province. This act does not apply to a hunter or trapper who actually hunts, if he is domiciled and resides in the Province and is a British subject.

Possession and sale: Persons engaged in buying, selling, or taking fur animals must, on or before the 10th of each month, make report to the minister. Unlawful to possess, buy, or sell skins of fur animals on which royalty has not been paid. No other restrictions on skins legally taken.

Shipment and export: Shipment and export prohibited, except of fur animals or furs on which royalties have been paid. Skins must be shipped open to view and each skin must be stamped to show royalty paid and be tagged as prescribed by the minister before being shipped in any manner. Packages must show names and addresses of consignor and consignee.

Propagation: The minister may grant permits to take animals alive for breeding purposes; nonresident license fee, from $5 to $25.

Bounties: Wolf, $15.

SASKATCHEWAN

Open seasons: [1]	*Dates inclusive*
Beaver (north of Township 52 only)	Nov. 1–Apr. 30.[2]
Mink, fisher, marten, fox, lynx	Nov. 1–Mar. 31.
Otter	Nov. 1–Apr. 30.
Muskrat: [3]	
North of Township 52 (also Nov. 7 to Dec. 14)	Mar. 1–May 14.
South of Township 53 (also Nov. 7 to Dec. 14)	Mar. 1–Apr. 30.
Other fur animals	Unprotected.

Prohibited methods: Unlawful to use poison to take fur animals, to spear or shoot beaver or muskrat, or to destroy beaver dams or muskrat houses.

Licenses: *Trapping:* Resident, $2 (children or wards under 18 of licensee may trap on his land under his license); nonresident, $25; resident licensee must return license on or before May 31 to chief game guardian with statement showing number of each kind of fur animals taken by him. *Fur dealer:* Resident, $10 (store); traveling dealer, $50; traveling agent for resident dealer: First permit $50, and $10 for permit north of Township 56; nonresident, $50 (store); traveling agent for nonresident or nonresident traveling dealer, $100; wholesale dealer, $100. *Taxidermist:* $5; licensee must keep duplicate receipt book and furnish a copy thereof every 3 months to the minister. *Tanner:* $10; licensee must keep record and make monthly report. Issued by department of agriculture, Regina. Licensed fur trader musmake annual report of operations. Resident treaty Indians may trap during open season witthout a license. Consent of owner or occupant required to trap on inclosed or cultivated lands of another.

SASKATCHEWAN—Continued

Possession and sale: Unlawful to buy, sell, or possess unprime pelts of protected fur animals.

Shipment and export: Packages containing fur animals must be plainly marked with full description of contents and names and addresses of consignor and consignee. Export of live fur animals prohibited except under permit of minister; fees for black or silver fox, $25; for cross or red fox or other live fur animal, $5. Unlawful to ship unprime furs or to export any raw furs on which royalty has not been paid. No other restrictions on skins legally taken.

Propagation: Permit required (fee, $1 annually) to operate a fur ranch. Permit to ship live fur animals bred in captivity is required; fee, $1 for each animal.

Bounties: Adult timber wolf, $10; pups of prairie or timber wolf, $1; paid only in properly gazetted wolf districts, when half is refunded from Provincial treasury.

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[1] *Saskatchewan:* Lieutenant governor in council may alter seasons. Trapping on game preserves prohibited.

[2] Beavers are protected on game preserves and south of Township 53 may be taken only under permit of minister.

[3] Minister may authorize the council of any municipality to destroy beavers or muskrats doing damage to highways or other public improvements.

YUKON

Open seasons: [1]	*Dates inclusive.*
Beaver, otter (see exception)	Jan. 1–June 30.
Exception: South of Arctic Circle	Jan. 1–May 15.
Marten	No open season.
Lynx, mink	Nov. 15–Apr. 1.
Muskrat (see exception)	Jan. 1–June 30.
Exception: North of Arctic Circle	Dec. 1–May 31.
Fox (see exception)	Nov. 15–Mar. 31.
Exception: South of Arctic Circle	Nov. 1–Jan. 31.
Other fur animals	Unprotected.

Prohibited methods: Use of poison, pitfalls, spears, or similar devices prohibited, except that commanding officer, Royal Canadian Mounted Police, Dawson, may grant permits to poison wolves and other predatory animals. Traps must be taken up within 15 days after close of open season.

Licenses: *Trapping:* None required of resident; nonresident, $100. *Fur buyer or dealer* (purchasing furs for sale or export): Nonresident, $150; resident, $25; mercantile establishment buying furs, $25 (required for each place of business other than head office); issued by gold commissioner or person designated by him.

Possession and sale: Skins legally taken may be possessed and sold at any time.

Shipment and export: Export of raw furs prohibited except under permit issued by direction of the commissioner and upon payment of the export tax. Export of live fox prohibited. (*See* "Propagation.")

Propagation: Registration of fox breeders required. Unlawful to export a fox not born in captivity or which has been in captivity for less than a year; any fox born in captivity may be exported under a permit (fee, $5). Fox and other fur ranches, if posted against trespass, may not be approached without owner's consent. No restriction on other fur animals. The killing or purchase from licensed hunters of male moose or caribou more than 1 year of age to feed fur animals raised in captivity is permitted under license (no fee) until June 1, 1926.

Bounties: None paid.

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[1] *Yukon:* Commissioner in council may alter seasons.

LAWS OF NEWFOUNDLAND

Open seasons:[1]	*Dates inclusive*
Otter, marten, lynx	Oct. 1–Mar. 31.
Fox	Oct. 15–Mar. 15.
Muskrat	Oct. 1–Apr. 30.
Beaver	No open season.[2]

Prohibited methods: Beaver house or dam must not be damaged by trapper. Use of poisons prohibited.

Bag limits: Twenty-five beavers in such localities as are opened by governor to trapping.

Licenses: *Trapping:* None required of residents except for beaver (beaver trapping license issued only to resident trappers of three years' standing); nonresident, $501; issued by justice. *Fur buyer and shipper:* 50 cents; issued by game and inland fisheries board. Fur buyer must report operations semiannually on or before June 30 and December 31 of each year.

Possession and sale: No restrictions on skins legally taken, except beaver.

Shipment and export: (*See* Licenses.) Unlawful to export a live fox unless raised in captivity. No restrictions on skins legally taken, except beaver.

Propagation: No restrictions, except as to fox. A fox farm must be licensed; the owner must at stated times make reports to the game and inland fisheries board, and the premises must be at all times open to inspection by officers of the board. Possession of fox cub or fox taken in close season is prohibited. Unlawful to export a fox not bred on a fox farm, or without permit from the board to export a fox bred in captivity.

Bounties: Crow, 20 cents.

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[1] *Newfoundland:* Unlawful to trap on Grand Lake Caribou Preserves.

[2] Governor in council may proclaim open season on beaver in certain localities. Skins of beavers must be forwarded through magistrate to department of marine and fisheries, which has sole power to purchase or export.

LAWS OF MEXICO [1]

Open seasons:	*Dates inclusive.*
Bear	Sept. 1–Oct. 31.
Beaver (male only)	Nov. 1–Feb. 28.

No open season: Females and young of beaver.

Licenses: Required for beaver: Resident, $20; nonresident, $40. Issued by Department of Agriculture and Development, Mexico City.

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[1] *Mexico:* For further information concerning trapping and fur laws, communicate with Director, Department of Agriculture and Development, Mexico City, Mexico.

OFFICIALS FROM WHOM COPIES OF LAWS RELATING TO FUR ANIMALS MAY BE OBTAINED

Alabama: Department of Game and Fisheries, Montgomery.
Alaska: Secretary of Agriculture, Washington, D. C.; or Executive Officer, Alaska Game Commission, Juneau.
Arizona: State Game Warden, Phoenix.
Arkansas: Secretary, Game and Fish Commission, Little Rock.
California: Executive Officer, Fish and Game Commission, Forum Building, Sacramento.
Colorado: State Game and Fish Commissioner, Denver.
Connecticut: Superintendent of Fisheries and Game, Hartford.
Delaware: Chief Game Warden, Dover.
District of Columbia: Superintendent Metropolitan Police, Washington.
Florida: Commissioner, Department of Game and Fresh-Water Fish, Jacksonville.
Georgia: Game and Fish Commissioner, Atlanta.
Hawaii: Fish and Game Commission, Honolulu.
Idaho: Fish and Game Warden, Boise.
Illinois: Director, Department of Conservation, Springfield.
Indiana: Superintendent, Division of Fisheries and Game, State House, Indianapolis.
Iowa: State Fish and Game Warden, Des Moines.
Kansas: State Fish and Game Warden, Pratt.
Kentucky: Executive Agent, Game and Fish Commission, Frankfort.
Louisiana: Commissioner of Conservation, Court Building, New Orleans.
Maine: Commissioner of Inland Fisheries and Game, State House, Augusta.
Maryland: State Game Warden, 514 Munsey Building, Baltimore.
Massachusetts: Director, Division of Fisheries and Game, State House, Boston.
Michigan: Director, Department of Conservation, Lansing.
Minnesota: Game and Fish Commissioner, Department of Conservation, St. Paul.
Mississippi: Secretary of State, Jackson; or Sheriff or County Clerk.
Missouri: Game and Fish Commissioner, Jefferson City.
Montana: State Fish and Game Warden, Helena.
Nebraska: State Game Warden, Lincoln.
Nevada: Secretary, State Fish and Game Commission, Reno.
New Hampshire: Fish and Game Commissioner, Concord.
New Jersey: Secretary, Board of Fish and Game Commissioners, Trenton.
New Mexico: Game and Fish Warden, Santa Fe.
New York: Secretary, Conservation Commission, Albany.
North Carolina: Legislative Reference Librarian, Raleigh.
North Dakota: Secretary, Game and Fish Board, Beach.
Ohio: Chief Game Warden, Department of Agriculture, Columbus.
Oklahoma: State Game and Fish Commission, Oklahoma City.
Oregon: State Game Warden, Portland.
Pennsylvania: Executive Secretary, Board of Game Commissioners, Harrisburg.
Rhode Island: Chairman, Commissioners of Birds, Providence.
South Carolina: Chief Game Warden, Columbia.
South Dakota: Director, Division of Game and Fish, Department of Agriculture, Pierre.
Tennessee: State Game and Fish Warden, Department of Agriculture, Nashville.
Texas: Game, Fish, and Oyster Commissioner, Austin.
Utah: Fish and Game Commissioner, Salt Lake City.
Vermont: Fish and Game Commissioner, Montpelier.
Virginia: Commissioner of Game and Inland Fisheries, Richmond.
Washington: Supervisor of Game and Game Fish, Box 384, Seattle.
West Virginia: Game and Fish Commission, Charleston; or Chief Game Protector, Buckhannon.
Wisconsin: State Conservation Commissioner, Madison.
Wyoming: State Game and Fish Commissioner, Cheyenne.

Alberta: Chief Game Guardian, Edmonton.
British Columbia: Secretary, Game Conservation Board, Vancouver.
Manitoba: Chief Game Guardian, Winnipeg.
New Brunswick: Chief Game and Fire Warden Fredericton.
Northwest Territories Director, Northwest Territories, Department of the Interior, Ottawa, Ontario.
Nova Scotia: Commissioner of Forests and Game, Halifax.
Ontario: Superintendent of Game and Fisheries, Toronto.
Prince Edward Island: Minister of Agriculture, Charlottetown.
Quebec: General Superintendent of Fisheries and Game, Quebec.
Saskatchewan: Chief Game Guardian, Regina.
Yukon: Gold Commissioner, Dawson.

Colony of Newfoundland: Secretary, Game and Inland Fisheries Board, St. John.

Mexico: Chief of the Game Department in Administration of Forestry and Game, Secretario de Fomento, City of Mexico.

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September 21, 1925

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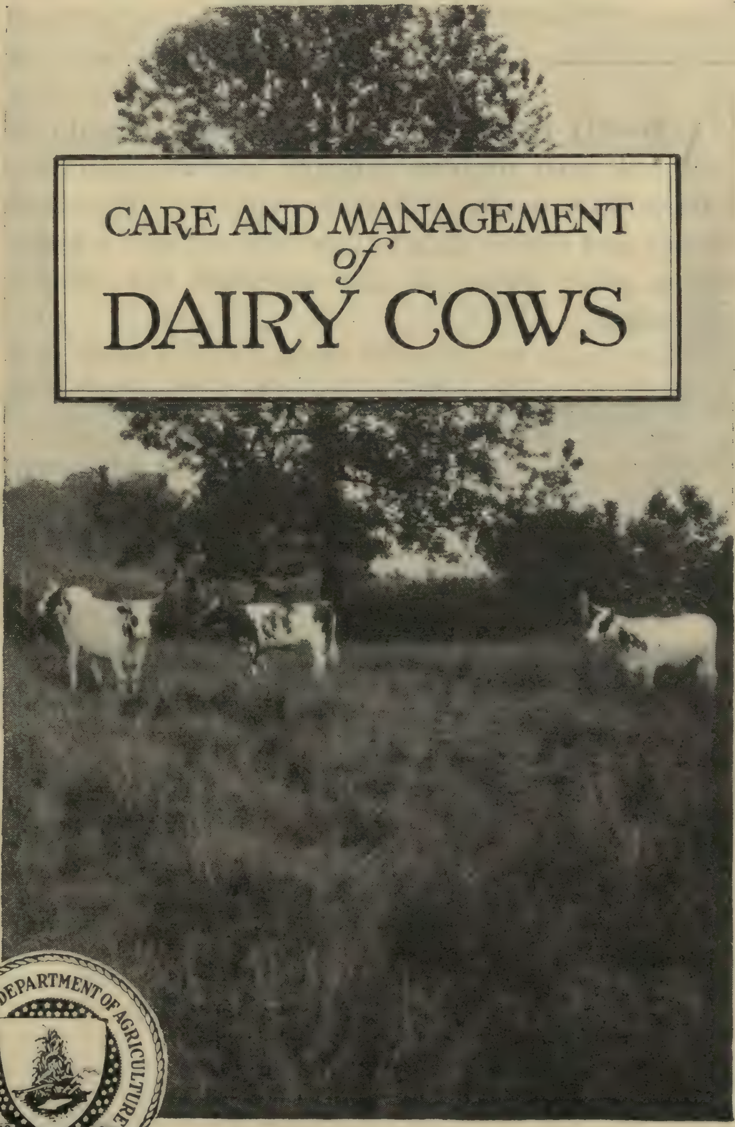
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1470

CARE AND MANAGEMENT of DAIRY COWS



A DAIRY HERD, to be most profitable, should be well bred, properly fed, and carefully managed. These three points are largely dependent upon each other, and a herd of dairy cows will not give a maximum return unless all these essentials have proper attention.

Cows must be properly sheltered; the fresh cow and the dry cow need care suitable to their different conditions; cleanliness in various aspects is necessary; building up the herd to the best advantage requires definite policies; diseases must be guarded against; records must be kept; and expenses must be kept down.

In managing a dairy herd there are many practices which experience has shown to be good. A brief statement of some of these forms the content of this bulletin.

Washington, D. C. Issued May, 1926

CARE AND MANAGEMENT OF DAIRY COWS

By T. E. Woodward, *Dairy Husbandman*, and J. R. Dawson, *Dairy Husbandman, Bureau of Dairying*

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BUILDING UP THE HERD

THERE ARE TWO METHODS of obtaining a high-producing herd of dairy cows. One method is to buy them, the other is to breed them. There are comparatively few men starting in the dairy business who can afford to purchase outright a high-producing herd. Although it is possible to buy good cows at reasonable prices in sections where there is a surplus of purebred or high-grade cattle for sale, it is only in exceptional cases that it is good business for a beginner to purchase a large number. As a rule the beginner is limited in funds, he does not understand the fundamentals of breeding and feeding, and in a majority of cases does not realize that high-producing cows must have better care and management than ordinary cattle.

It is usually better practice to start with a smaller number of cows and use a desirable purebred bull. These cows must be handled properly and the heifers selected from the best cows to build up the herd. After a time, when finances permit, one or two purebred females can be purchased as a foundation for a purebred herd. In the meantime considerable knowledge will have been gained in the care and management of dairy cattle, and the chance for financial loss will have been reduced to a minimum. This may seem like a slow method, but it is sure. It takes several years of intelligent effort and thought to build up and maintain a good herd of cows—either purebreds or grades—and the business can not be learned in a few months.

Several breeds of dairy cattle are being used in the United States and have proved satisfactory. There are good cows and poor cows in all breeds. For this reason, individual selection should receive as much attention as the breed.[1]

Breeds of dairy cattle should never be crossed. The present breeds of dairy cattle are the result of many years of intelligent breeding along definite lines. By this method breeders have developed certain valuable characteristics which are transmitted when animals of the same breed are mated. When two animals of different breeds are crossed, the characteristics of both breeds are so mixed that they are not passed on to future generations with any degree of certainty.

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[1] For information on breeds of dairy cattle, see Farmers' Bulletin 1443, U. S. Department of Agriculture.

A purebred sire should always be used. The bull is the sire of all the calves in a herd, therefore his influence will be multiplied a great many times faster than that of any one cow. The better the bull, the better the future herd will be.

Purebred cattle on the average produce more than grades. A tabulation of 17,405 yearly records of cow-testing association cows, made by the Bureau of Dairying of the United States Department of Agriculture, shows the relative production of purebreds and grades. Table 1 gives the results of this study.

TABLE 1.—*Comparative production of purebred and grade cows*

	Purebreds	Grades
Number of records	2,919	14,486
Average pounds of milk	7,182	6,261
Average pounds of butterfat	288	258

The purebred cattle excelled the grades by almost 1,000 pounds of milk and 30 pounds of butterfat. All these cows were in cow-testing associations and probably received much the same care and management. However, purity of breeding does not always insure greater or more economical production. There are many herds of carefully selected grade cows that produce as well as or better than many purebreds of the same breed. Over 90 per cent of the dairy products of this country are produced by grade cows, and this will continue to be the case for many years to come. However, it is the blood of the purebred in our grade cows that makes them the high producers they are.

THE DRY COW

It is generally considered that a cow should be dry for a period before calving, for four principal reasons: (1) To give the organs concerned in milk secretion a rest; (2) to permit the nutrients of the feed to be used for the development of the fetus instead of for the production of milk; (3) to enable the cow to replenish any stores of minerals which may have become depleted through the production of milk; and (4) to permit the cow to build up a reserve of body tissue before calving.

LENGTH OF DRY PERIOD

That a cow should be dry for a certain period has been demonstrated to be sound economic practice. The proper length of the dry period seems to depend on the quantity of milk which the cow has produced and her condition as regards flesh. It is probable that the greater the yield of milk the greater is the depletion of the stores of nutrients used in the secretion of milk and the longer the dry period required. Cows of low or medium production are not thought to require so long a dry period as high producers. Such cows should be dry a month or six weeks, provided they are in a good state of flesh. Thin cows may need a somewhat longer period. High producers may require two months or more to permit them to get in proper condition for calving.

FEEDING THE DRY COW

Cows normally lose flesh for three or four weeks after calving because they can not consume sufficient feed to provide adequately for both the milk flow and the maintenance of body weight. In order, therefore, that the cow may not become too thin after calving, it is necessary that she carry considerable flesh at time of parturition. It is well known also that cows in good condition at time of calving will start off the lactation period at a higher level of production than thin cows; this results in a larger yield of milk for the year. There is no economy in having a cow thin at calving time.

The feed during the dry period should be high in minerals, especially calcium (lime), since it has been shown by investigations at several experiment stations that this is the element most likely to be depleted. Good pasture in the summer and properly cured leguminous hay in the winter will supply this calcium. Considerable protein is required for the development of the fetus. For this reason and because most of the high-protein feeds such as the oil meals are likewise rich in phosphorus, which is used along with the calcium in storing up minerals in the animal body, the ration should contain considerable protein. The quantity of feed supplied should be sufficient to bring the cow to a proper state of flesh at calving time.

DRYING OFF

Most cows can be dried off by merely lessening gradually the frequency of milking. That is, first miss one milking, then miss two, then three, etc. When the daily production is only 6 or 8 pounds milking may be stopped entirely. The udder of the cow should then be let alone and nothing done to stimulate the secretion of milk. It is probably best after several days to draw out the milk that has accumulated, though the necessity for this has never been proved, as this milk will be absorbed in a short time. With persistent producers it is often necessary to reduce the allowance of feed, especially grain. With any cow the time required for drying off may be shortened by withholding a portion of the feed.

THE FRESH COW

CARE AT CALVING TIME

In handling dry cows that are heavy with calf care should be taken to prevent injury by slipping on stable floors or ice, by two or more cows crowding through doorways, and by pregnant cows mounting other cows that may be in heat. All cows in heat should be confined, or at least separated from the cows that are heavily pregnant. In other particulars the pregnant cow can be handled like the rest of the herd.

A week or two before the cow is due to calve she should be kept under rather close observation, as she may need special attention when calving occurs. If the cow has been running on pasture, she may continue to do so; but her condition should be observed at least twice daily. If calving occurs during the winter, the cow should be placed in a clean, roomy, well-bedded box stall. Sometimes the udder becomes so large and swollen that it appears desirable to draw out some of the milk previous to calving; however, this is seldom necessary and should be avoided if possible, because it stimulates further secretion and because the first milk or colostrum is beneficial to the calf. The cow should be kept as quiet as possible and fed a laxative ration, wheat bran and linseed oil meal being especially desirable. The ration should not contain too much roughage, which on account of its bulk adds to the discomfort of the cow.

Immediately after the cow has calved it is a good practice to give her warm water to drink, and follow this with a warm bran mash, the idea being that if the cow becomes chilled at such a time the afterbirth may not be passed so readily, and the animal may be predisposed to other ailments. It is also thought best not to draw all the milk from the udder for a day or two after calving. This may help in the prevention of milk fever. After a couple of days, provided everything is proceeding normally, the calf may be removed and the cow placed in the stable with the milking herd. As much roughage may be allowed as the cow will consume, but the concentrates should be fed sparingly at first and gradually increased. With good producers not less than three weeks should be taken to get them up to full feed. The grain fed to poor or medium producers may reach the full quantity a little earlier. Too much concentrated feed at this time is likely to cause digestive disturbances and hinder the reduction of swelling in the udder. In general, it is better to err in not giving sufficient concentrates than in giving too much. The quantity to be given just after calving will depend upon the size of the cow, her production, and the condition of her udder; and will usually be from 4 to 7 pounds per day.

Cows should always be treated with kindness. No person fit to be a dairyman will treat them otherwise. The character of a person is shown by the way he handles cows and other livestock. Kindness pays in dollars and cents, but such incentive should not be necessary to obtain for the sow the treatment that is justly due her.

SEASON OF YEAR FOR FRESHENING

The influence of the season of freshening on the production of dairy cows has been the basis of considerable investigation. The Bureau of Dairying has compiled some facts in regard to the most profitable season for cows to freshen, and these are published in Department Bulletin 1071. The conclusions are based on a study of 10,870 yearly records in 64 cow-testing associations, and are summarized in Table 2.

Table 2.—*Date of freshening, by seasons, with average yearly feed and production records, per cow*

Season	Number of cows	Milk production	Butterfat production	Cost of roughage	Cost of grain	Cost of feed	Income over cost of feed
		Pounds	*Pounds*				
Spring (March, April, and May)	3,196	5,842	236	$37.51	$19.22	$56.73	$70.73
Summer (June, July, and August)	1,328	5,941	236	37.62	22.48	60.10	66.59
Fall (September, October, and November)	2,862	6,689	268	38.94	28.45	67.39	76.65
Winter (December, January, and February)	3,484	6,439	258	37.65	25.51	63.16	75.66
Total and averages	10,870	6,269	252	37.95	24.06	62.01	73.36

Cows that freshened in the fall months ranked highest in average yearly production of milk and butterfat, in cost of feed, and in income over cost of feed; the cows that freshened in the winter months ranked second in these respects; on the average, those that calved in the spring and summer produced the least milk and butterfat and returned the smallest income over cost of feed.

The cost of feed was considerably higher for the winter-freshening cows than for the cows freshening in the summer months. This is no doubt owing to the fact that the former produced the most milk and therefore required the heaviest ration when the cost of feed was highest. However, in the feed cost per unit of milk there was little difference between the cows freshening in the different seasons.

The cost of roughage was found to be practically the same per cow for all seasons of freshening; but the grain cost was $9.23 more for those freshening in the fall than for those which freshened in the spring. However, this increased feed cost was more than offset by the 32 pounds more butterfat produced by the fall-freshening cows.

Cows that calve in the spring usually give a big flow of milk during the summer months when feed is cheap. Butterfat is also usually low in price at that season. Then, too, the spring-freshening cow is very likely to receive a severe setback in milk production when the heat, flies, and short pasture appear. It is difficult to get her back to high production during the fall and winter; consequently she must be carried through the winter on expensive feeds with a very small margin of profit.

There are several advantages in having cows freshen in the fall. Butterfat usually brings a higher price during the fall and winter months. Labor is easier to obtain then, and there is more time to care for the calves and a large supply of milk. The fall-freshening cow, if properly fed and handled, will, as a rule, produce well during the winter months, falling off as spring opens. At this time the spring pasture grass will act as a stimulus and cause increased production during the spring and early summer. The period of low production will come during July and August, when conditions are extremely unfavorable for high production. It is undesirable to have cows freshen during the hot summer months, because of hot weather, flies, and dried-up pastures. Fall-dropped calves are easier to raise and usually less subject to diseases.

The dairyman who sells his milk to a city retail trade should have his cows freshen at all seasons of the year in order to keep up a steady, constant flow of milk. However, this point is not so important for dairymen who separate the milk, sell cream, and use the skim milk for feeding purposes.

MILKING

REGULARITY

Of all dairy operations, milking on most farms takes the most time and to many persons is the most irksome. It has commonly been assumed that cows should not only be milked regularly but that they should also be milked each time by the same man. Doubtless this has had much to do with many persons' distaste for dairy work.

Experiments at the Bureau of Dairying experimental farm at Beltsville, Md., show that with cows that are average to good, milking may take place at irregular hours without any marked effect upon production. Whether very high producers would show similar results has not been determined. It was also found that when irregular milking was accompanied by irregular feeding the production was lessened about 5 per cent. Apparently cows are more sensitive to changes in the feeding routine than to variation in the hours of milking. The conclusion is not to be drawn from these experiments that regularity in doing the dairy work is a matter of little importance, but rather that cows can occasionally be milked earlier or later than usual if there is something else to which the dairyman desires to give his time.

Though it is generally believed that a cow will produce more when milked always by the same person, the practice in many large dairies where there are several milkers is to milk the cows as they come, rather than to reserve certain cows for each man. At the Beltsville station, 12 cows were divided into three groups of four cows each, and each group was milked regularly by the same man for 40 days. The 12 cows were then milked by the same three men in such a way that no cow was milked twice in succession by the same man. After 40 days the cows were changed to regular milking again for 40 days. The results show an increase of about 0.05 per cent in the milk and fat through steady milking by the same man. This is so little as to be almost negligible.

FREQUENCY

The oftener a cow is milked, within certain limits, the greater the production. This accounts for the fact that many cows on test for the advanced registry or register of merit are milked oftener than is the practice with the ordinary herd. The increase that may be expected by milking three times a day instead of twice has not yet been definitely determined. While some estimate the increase as high as 25 per cent, experiments at Beltsville show the average increase in the yield of good cows for short periods (40 days) to be about 12 per cent. Preliminary figures also show the increase for long periods (one year) to be about 18 per cent. The cows milked three times a day were more persistent in their yield of milk than those milked twice a day.

The amount of increase due to more frequent milking seems to be dependent upon the quantity of production and the capacity of the udder. When the udder becomes much distended, milk secretion is checked, and if the production and udder capacity are such that this occurs on twice a day milking, a greater percentage increase may be obtained by milking three times than would be obtained by an extra milking of cows with larger udders. Similar experiments comparing three and four times a day milking for short periods show an increase of slightly over 6 per cent by milking four times.

In a few dairies all the cows are milked three times a day; in a few others only some of the higher producers are milked three times a day. The economy of milking more than twice a day is a matter which must be figured out by the individual dairyman from the actual cost of the extra milking and the value of the product, bearing in mind that approximately 1 pound more of concentrated feed will be required for each 2 or 3 pounds of extra milk produced. In the absence of more extended experimental data, one can safely estimate the increase in production for short periods, from milking three times a day, as 12 per cent more than the production from milking twice a day; and the increase by milking four times, as 6 or 7 per cent over milking three times a day. One can also estimate the increase from milking three times instead of twice, for long periods, at 18 per cent.

FIG. 1.—Milking by hand

MILKING BY HAND

Proper hand milking (fig. 1) should have for its objects, aside from sanitation, to draw the milk with the least discomfort to the cow, to draw it as quickly as possible, and to get all the milk. Some milkers, through unnecessary roughness, an unusually strong grip, or long finger nails, keep the cow uneasy during milking. This may lead to kicking. There is no advantage in slow milking, and experiments at the Wisconsin station[2] showed that the percentage of fat may be lowered by prolonging the milking operation.

Unless all the milk is removed from the udder, it is thought that the milk remaining will interfere with the functioning of the gland and result in a diminished production. When the calf runs with the cow, probably this is the way in which nature adjusts the supply to meet the demand. In order to get all the milk certain manipulations of the udder have been practiced. These manipulations apparently increase the production slightly, but they have never come into general use, although an abbreviated modification of the method is practical. An upward pressure on each quarter of the udder for a few times when milking is nearly completed will help to bring the milk into the teats where it can be drawn.

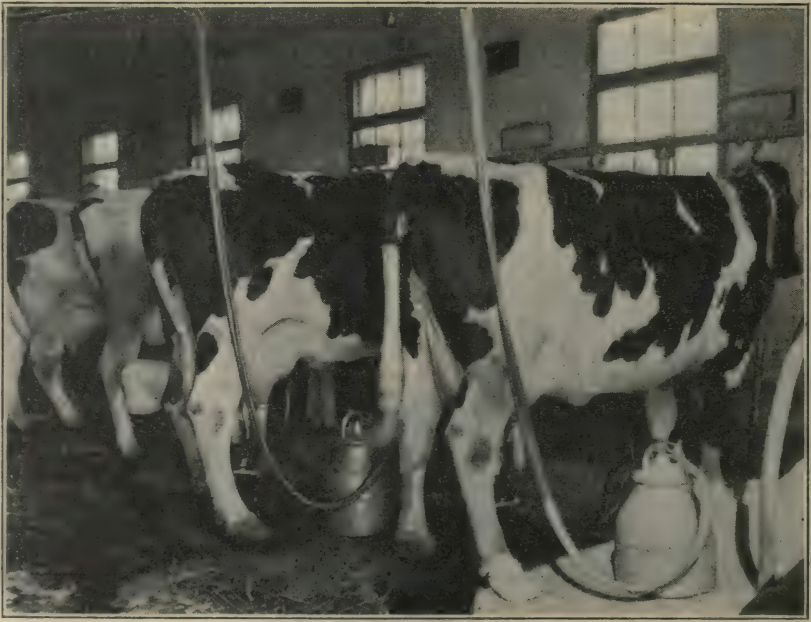

FIG. 2.—A mechanical milker

THE MECHANICAL MILKER

The mechanical milker (fig. 2) is a success on many dairy farms. It saves labor, is easier, and to many persons its operation is more agreeable than hand milking. The cost of installation and the labor of keeping the machines in proper sanitary condition make them impractical if the herds are very small.

It is possible to have milk with a low bacteria count when machine drawn by giving proper attention to cleansing and sterilizing. In many instances, however, just as with cream separators, this matter has been neglected or carelessly done. Theoretically, machine-drawn milk should be cleaner than that drawn by hand, because it is better protected from contamination by the cow, the milker, and the stable air.

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[2] Sixth annual report.

So far as quantity of production is concerned, the mechanical milker seems to give as good results as ordinary hand milking. It is the general practice for a hand milker to follow the machine to see that the milking is completely done and to draw any milk that is left.

It has been claimed that machine milking causes udder troubles, and with the earlier models there was doubtless some ground for such a claim, especially if they were left on the teats too long. More recent makes and styles, which are constructed so as not to interfere with the circulation of blood through the teats, are thought to lessen the likelihood of such trouble. Failures with the mechanical milker can usually be traced to a lack of mechanical knowledge on the part of the operator, carelessness of operation, or lack of attention to proper cleaning of the machine. The increased use of the milking machine indicates its practicability.

KEEPING RECORDS

In order properly to manage a herd of dairy cows, it is necessary to keep records. The system need not be elaborate, but should be sufficient to furnish accurate information on milk and butterfat production of individual animals and quantity of feed consumed. In addition, breeding dates should be recorded and a plan of identification and registration of the purebred animals should be followed. One should not rely on memory for such records, but should put every item down in writing in such a manner that it can be easily referred to when need arises. Whatever system is adopted should be continued. The records should not be allowed to lapse.

PRODUCTION RECORDS

The principal reason for keeping milk-production records is to show definitely which cows are profitable and which are not. The inferior cows can then be disposed of and the better ones kept for production and breeding purposes.

Another important reason for keeping daily records is that they furnish information which is used as a basis for feeding. Cows should be fed according to the quantity of milk or butterfat produced, and the daily production must be known. Sickness or other abnormal conditions are generally accompanied and often preceded by a decline in milk production. This decline can easily be noticed if the practice of weighing and recording the milk daily is followed.

A spring-balance scales is necessary. (See fig. 3.) These scales are equipped with adjustable hands, one of which is set at zero when an empty pail is hung on the scale. The quantity of milk then may be read without subtracting the weight of the bucket. The milk scales should be graduated to tenths of a pound. If milk pails of different sizes are used by the milkers, it is a good idea to keep a weigh pail at the scales to avoid confusion. The scales should be hung in a convenient place in the barn or milk room.

A suitable sheet for recording the daily weight should be placed in a clean, protected place near the scales. These sheets may be so arranged (fig. 4) that spaces are provided for writing the name or number of the cow and spaces for recording the weights of the milk both morning and evening. Some use sheets with spaces for seven days only, but the more common way is to have spaces for the entire month. Scales and milk sheets can be obtained from dairy supply houses. Many publishers of dairy periodicals also distribute milk sheets for a nominal price.

At regular intervals samples of milk from individual animals should be tested for butterfat.[3] A common practice is to take a composite sample of milk from each cow for three consecutive days, about the middle of each month, and test this for butterfat. The butterfat percentage thus obtained is used as the average test for the month and the monthly butterfat production is computed from this.

There are other methods that can be used, such as weighing and testing the milk for one day during the month. The total yearly production for each cow, as shown by such tests, will be close enough to actual production for practical purposes. In some cases the milk is weighed and tested one day every two or three months. This method is not so accurate, but it is better than no test at all.

In many sections of the country cow-testing associations are in operation. If a dairyman is a member of a cow-testing association the detailed production records of his cows are kept by the tester, who is hired by the association (fig. 5). The tester visits each member's herd one day out of each month, weighs and tests the milk of individual cows for that day, weighs the feed, and figures the total quantity of milk and butterfat given and the feed consumed for the month. This system has proved to be an inexpensive and reliable method of keeping herd-production records for a number of dairymen in a community.[4]

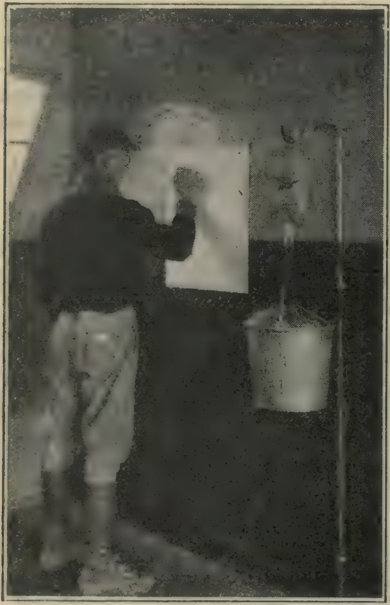

FIG. 3.—Weighing and recording the milk

BREEDING RECORDS

A record should be made of date of breeding, the bull to which bred, and date of expected calving. The gestation period for cows is approximately 280 days. For convenience it is well to have a gestation table handy for reference in estimating date of calving.

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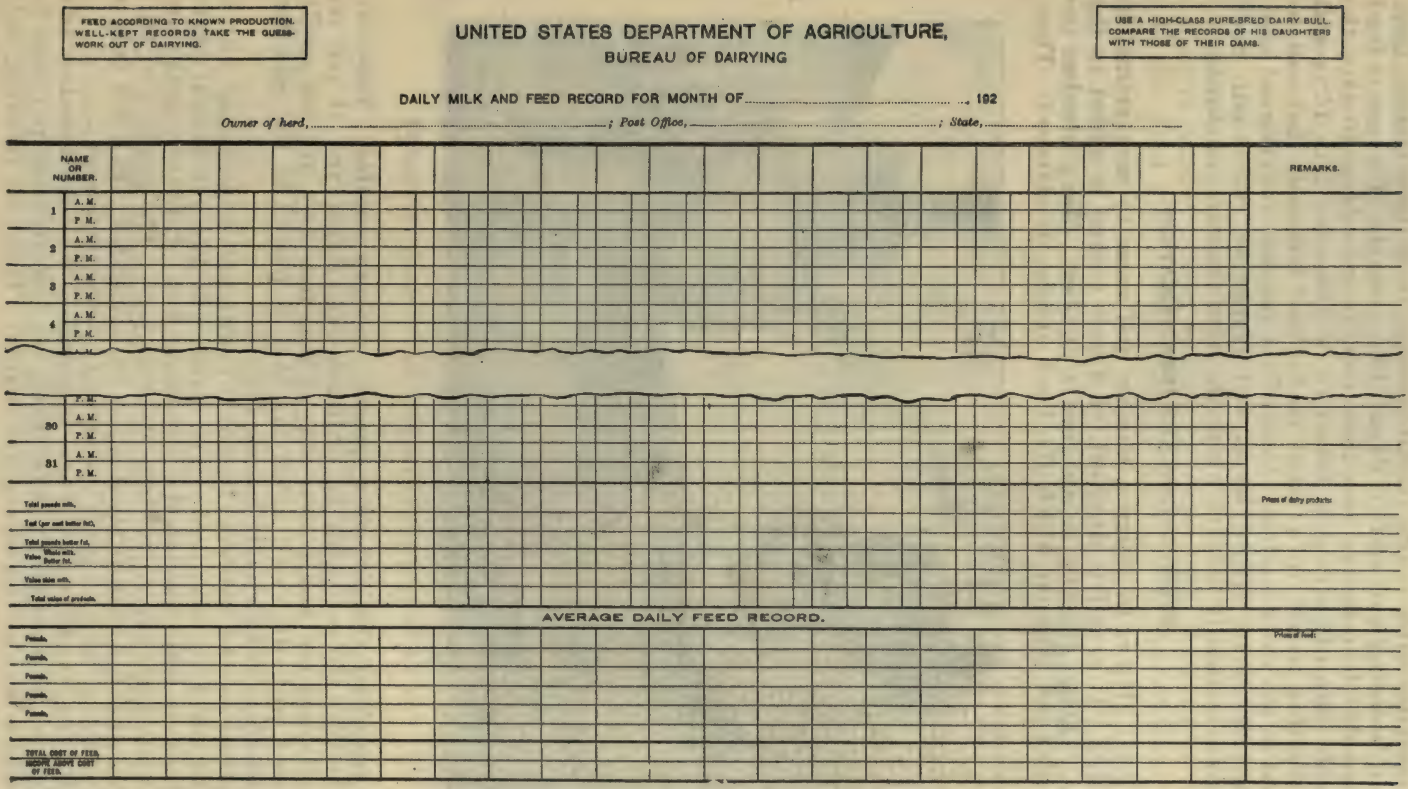
[3] For directions on testing milk, see "Chemical Testing of Milk and Cream," U. S. Department of Agriculture, A–12.

[4] For further information concerning cow-testing associations, see Farmers' Bulletin 1446.



FEED ACCORDING TO KNOWN PRODUCTION. WELL-KEPT RECORDS TAKE THE GUESSWORK OUT OF DAIRYING.

UNITED STATES DEPARTMENT OF AGRICULTURE,
BUREAU OF DAIRYING

USE A HIGH-CLASS PURE-BRED DAIRY BULL. COMPARE THE RECORDS OF HIS DAUGHTERS WITH THOSE OF THEIR DAMS.

DAILY MILK AND FEED RECORD FOR MONTH OF ...., 192

Owner of herd, ...; *Post Office,* ....; *State,* ....

NAME OR NUMBER.

REMARKS.

1 A. M.
P. M.
2 A. M.
P. M.
3 A. M.
P. M.
4 A. M.
P. M.

30 A. M.
P. M.
31 A. M.
P. M.

Total pounds milk,
Test (per cent butter fat),
Total pounds butter fat,
Value Whole milk.
Butter fat.
Value skim milk,
Total value of products.

Prices of dairy products:

AVERAGE DAILY FEED RECORD.

Pounds,
Pounds,
Pounds,
Pounds,
Pounds,

Prices of feed:

TOTAL COST OF FEED.
INCOME ABOVE COST OF FEED.

FIG. 4.—Sheet for recording daily milk weights

If a gestation table is not available, count back three months from date of breeding and add 10 days. For example, if a cow is bred on March 10, by counting back three months and adding 10 days, the probable date of calving is found to be December 20. It is well to have this record in a small pocket-size notebook that can be carried in the work clothes. Most of the national dairy-breed associations distribute record books and blanks of this kind. Such books are especially helpful where the herd includes purebreds.

REGISTRATION AND IDENTIFICATION

A good plan is to assign a number and name to each animal in the herd. If a calf is dropped, or a new animal is added to the herd, it should likewise be assigned a number. Many breeders use fiber-disk ear tags on which the herd number is stamped. These tags are about the size of a quarter and are durable. They are attached to the ear with an ordinary hog ringer and if put on properly are not easily torn out. Then, too, they are not easily confused with the small metal tag that is placed in the ears for identification in tuberculin testing (fig. 6).

FIG. 5.—The tester tests the milk for percentage of butterfat

A strap around the neck, to which is attached a metal tag with a number on it, is also used. The strap will last for several years and there is little likelihood of its being lost. However, straps are somewhat more expensive than fiber ear tags. The practice of slitting the ears for identification is not recommended. It is not only a cruel practice but also gives the animal a bad appearance.

Tattooing numbers in the ears is practiced by some breeders and is required by some breed associations for identification purposes in connection with advanced register testing. There are tattooing outfits on the market for doing this work. If the tattooing is properly done, it is reliable and will last for the lifetime of the animal. However, the tattoo marks do not show up distinctly on animals having dark skins. Even on light skins the tattoo numbers are often difficult to make out, and it becomes necessary to catch and hold the animal in order to see the numbers.

A diagram of each animal can be drawn on loose-leaf forms provided by the various breed associations. On the opposite side of this sheet is usually a three or four generation blank pedigree. Forms of this kind filled out for each animal in the herd and kept in a holder will be of great help to the owner, especially if he has purebreds.

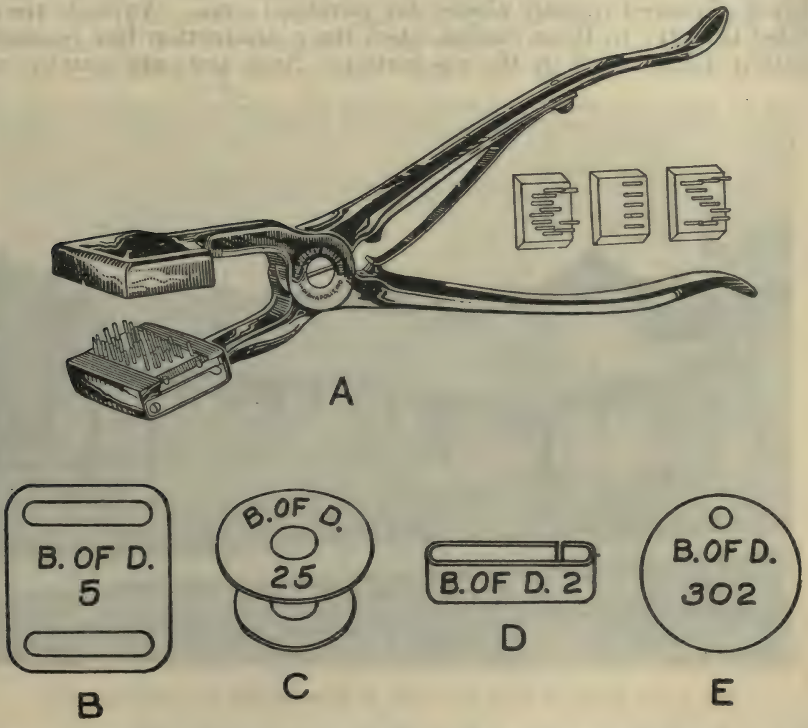


FIG. 6.—Methods of marking cattle: A, tattooing outfit; B, metal bag to go on strap around neck; C and D, metal tags; E, fiber disk ear tag

Registration papers on all purebred animals should be on hand. Calves should be registered as soon as practicable. The various national dairy-breed associations furnish directions and advice for registration. Their names and addresses are as follows:

American Guernsey Cattle Club, Peterboro, N. H.
American Jersey Cattle Club, 324 West Twenty-third Street, New York, N. Y.
Ayrshire Breeders' Association, Brandon, Vt.
Brown Swiss Cattle Breeders' Association, Beloit, Wis.
Dutch Belted Cattle Association of America, Rockville, Conn.
Holstein-Friesian Association of America, Brattleboro, Vt.

In addition to the dairy-cattle names above, some breeds primarily developed for beef production are occasionally bred and used as dairy cattle. Their associations are as follows:

American Devon Cattle Club, 51 Cornhill, Boston, Mass.
American Shorthorn Breeders' Association, 13 Dexter Park Avenue, Stock Yards, Chicago, Ill.
Milking Shorthorn Society, Independence, Iowa.
Red Polled Cattle Club of America, Richland Center, Wis.

ADVANCED REGISTER TESTING

The various national breed associations for dairy cattle have established advanced-register classes for purebred cows. Animals are entitled to entry in these classes when their production has reached a certain standard set by the association. Such tests are usually conducted by representatives of the State agricultural colleges or experiment stations. Rules and regulations for conducting these tests differ according to the breed and the kind of test undertaken. Information can be obtained by writing the breed associations or the State agricultural experiment stations.

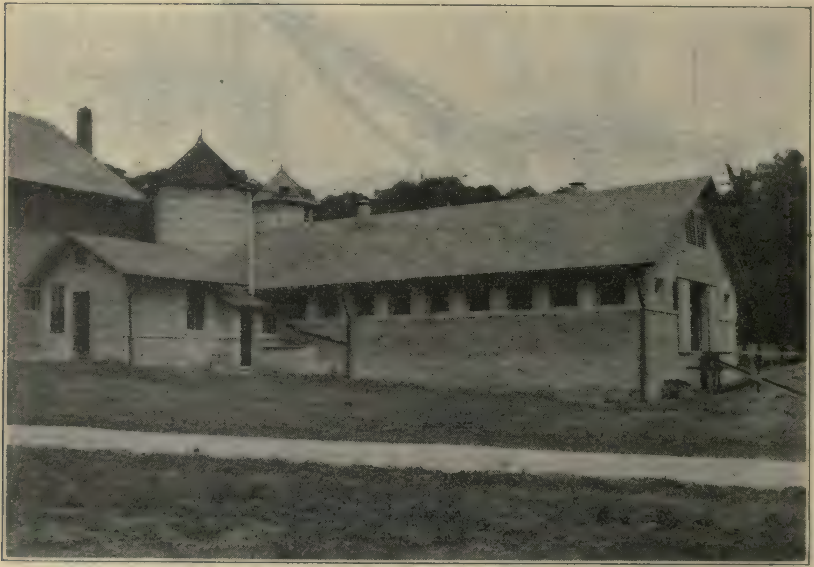


FIG. 7.—A one-story barn with milk room connected by covered passage

STABLE AND YARD

The main essentials in housing dairy cows in the winter seem to be to keep them dry and out of the wind and drafts and to provide plenty of fresh air and sunlight. Apparently the matter of temperature in itself is not a vital consideration, except perhaps in the most severe portions of the United States. It has been noted at the Beltsville station (in Maryland) that cows do their best in the coldest weather and their poorest during the hot summer months.

Probably there is no advantage in keeping the stable temperature much above freezing, and there may be a disadvantage if the temperature rises above 60° F.

TYPES OF BARN

Types of barns which can be made suitable for dairy cows are the basement barn, one-story stable, two-story barn, round barn, and open shed or covered barnyard (figs. 7, 8, 9, and 10).

In the basement barn the cows usually are housed on the lower floor. Owing to the greater protection from the weather afforded by such a barn, it is likely to be warmer than other types in the winter, and it is probably for this reason that more such barns are to be found in the North than in the South. Many basement barns may be criticized for lack of sufficient light and for being so low that the slope away from the stable is not enough to afford proper drainage of the cow yards. The ventilation and lighting of such barns is generally poorer than that of other types, but they can be remodeled so as to be satisfactory in these respects.[5]

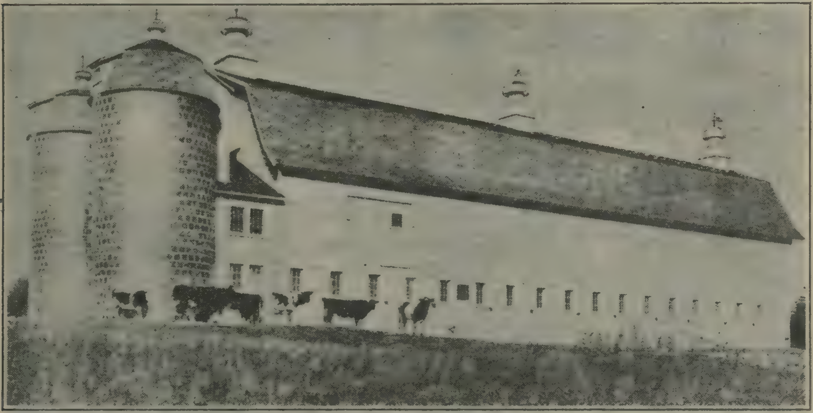


FIG. 8.—A two-story barn. Note space for hay storage

The one-story and two-story barns (figs. 7 and 8) can be well lighted and ventilated and can be kept in a sanitary condition more easily than a basement barn. However, with a one-story barn other facilities must be provided for the storage of hay. For this reason the expense of housing both cows and feed will in most cases be greater with the one-story than with the two-story barn in which the same roof covers both the cows and the feed. The fire hazard is usually greater in the two-story barn.

In the round barn (fig. 9) more space can be inclosed with the same amount of building material than in other types, and it appears that this is the chief advantage which may be claimed for it. The practice of locating the silo in the center of the barn may put the silage in the most convenient place for feeding, but it is likely to fill the stable with odors which may taint the milk; and certainly a silo so located is not so easily filled as one outside the barn.

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[5] For information on barn construction, see Farmers' Bulletin 1342.

OPEN SHED OR COVERED BARNYARD

The open shed or covered barnyard (fig. 10) is a practical method of housing dairy cows. It provides the best known method of saving and preserving all the fertilizing constituents of the manure; it permits the feeding under shelter of rough materials such as cornstalks and makes possible their utilization for bedding; when there is plenty of bedding, cows so housed keep cleaner than those confined in stanchions. These are the principal points in favor of the open-shed system.

In an experiment at the Beltsville station it was found that the cows in the open shed produced a little more milk, but at a greater cost for feed, than the cows in the closed barn. The more timid cows were fought away from the feed racks in the shed, which resulted in a much lower production from such cows. Probably it would be a matter of economy to confine the cows at feeding time. Cows so housed should be dehorned.

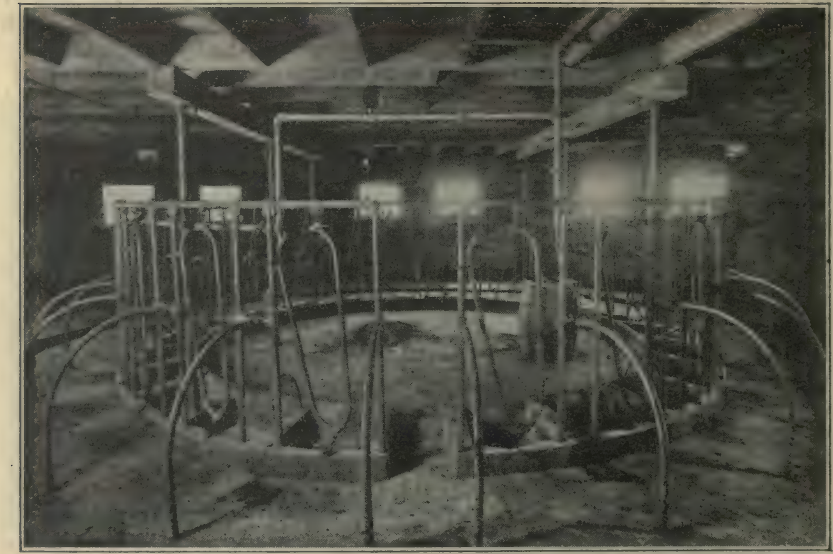

FIG. 9.—Arrangement of equipment in a round barn

The labor required under the two systems was slightly greater with the open shed. Had the cows been milked in the open shed this would not have been the case, but since this practice is not recommended in the production of market milk, the cows in this experiment were taken to a separate stable for milking. Sixty-eight per cent more bedding was used in the open shed.

STALL EQUIPMENT

Of the various methods of confining cows, the swinging stanchion (fig. 11), which allows considerable freedom, has met with the greatest popular approval. The old-fashioned rigid stanchion is being replaced with this more humane device. But even the swinging stanchion fails to allow enough freedom to meet the desires of many dairymen who are trying to get maximum production regardless of expense. These dairymen use box stalls.

By confining in stanchions less space is required, the labor of feeding, milking, and cleaning the stable is materially lessened, and the bedding needed is only one-fourth to one-third as much as box stalls require. However, cows so confined are more liable to have their teats injured by being stepped on, either by themselves or by other cows. In experiments at the Beltsville station in which 12 cows were kept in box stalls and stanchions in alternate periods, it was found that the cows in box stalls produced less than 4 per cent more milk than those kept in stanchions. The increase was not enough to pay for the extra labor and bedding required.

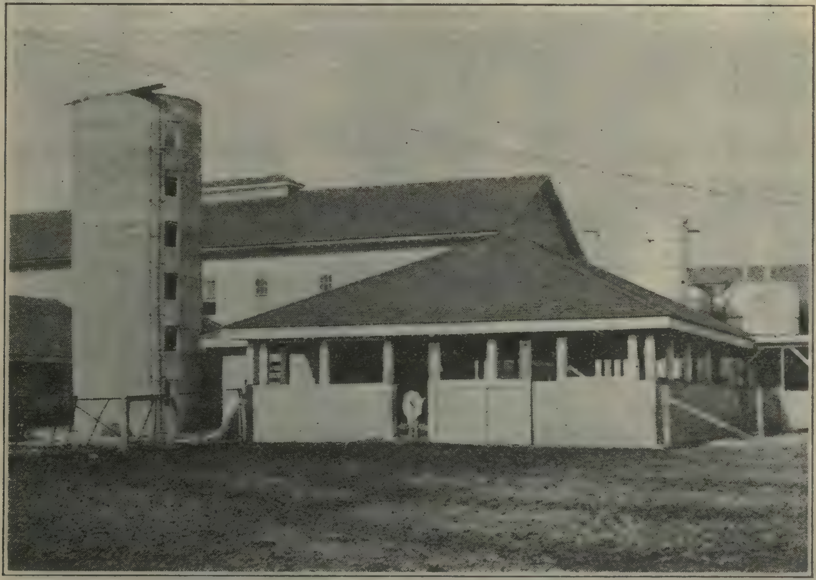

FIG. 10.—An open shed for housing dairy cows. The roughage is fed in this shed. Grain is fed in the milking barn

Dirt floors should not be used in a dairy stable. They are insanitary, they can not be flushed, and holes soon appear. A stable floor should be durable and easy to keep clean. Concrete should be neither so smooth as to be slippery nor so rough as to make thorough cleaning difficult.[6]

PAINT AND WHITEWASH

If the inside of the cow stable is to be painted, the woodwork or plastering should be as smooth as possible to avoid the use of excessive quantities of paint. If it is to be whitewashed a rough surface is preferable, as whitewash will not adhere so well to smooth surfaces. White paint made of white lead and linseed oil when used in the cow stable will turn yellow. If the cow stable is to be painted white, therefore, it is better to use some kind of paint which does not contain linseed oil. If the stable is painted gray or some color other than white, the change in color will not be so noticeable. In such cases linseed-oil paint can be used more advantageously.

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[6] The construction of various kinds of floors, as well as ventilating and lighting, is discussed in Farmers' Bulletin 1342, Dairy Barn Construction.

Cow stables are usually whitewashed once or twice a year. There are many whitewash formulas which call for the addition to the lime and water of other substances, such as salt or skim milk. Just how much advantage there is in adding such materials is a matter of conjecture. Satisfactory whitewash can be made by the use of only lime and water. The ordinary hydrated lime when mixed with water makes a good whitewash; or the quicklime ordinarily called lump lime may be slacked with a minimum quantity of water and this used in place of the commercially prepared hydrate of lime. Only freshly burned lump lime should be used, and any that is air-slacked should be discarded, as whitewash made from such lime will not stick.

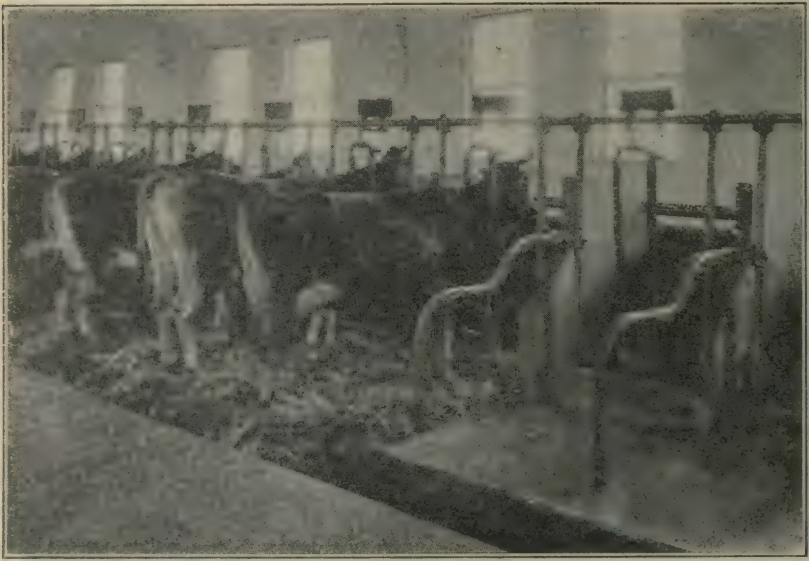

FIG. 11.—Interior of a modern dairy barn. Note the swinging stanchions, concrete floor, and gutter. The mangers are designed for experimental feeding

Whitewash may be applied with a brush (fig. 12) or with a spray pump. It can be applied more heavily with a brush, and sometimes one coat will give as good results as two with the sprayer. Spraying, of course, is quicker, but smears up the floor and equipment more than the brush method. But no matter what method of application is used, it will save time in cleaning if the equipment is covered with old bags or similar material. If the floor is kept wet while the whitewashing is in progress, the whitewash that is dropped will not stick so tight but that it can be dislodged readily with water and a brush or broom.

EXERCISE

Exercising cows by making them walk 3 miles a day was found at the Beltsville station to cause a greater feed consumption and a slightly higher percentage of fat in the milk, but the quantity of milk remained about the same. The extra feed consumed cost more than the increased quantity of fat was worth. So far as production is concerned, a cow needs no more exercise than she will get by walking at will about a small yard. The writers know of no experiment on the influence of exercise upon the health that has been conducted over a long enough period to warrant any conclusions regarding it.

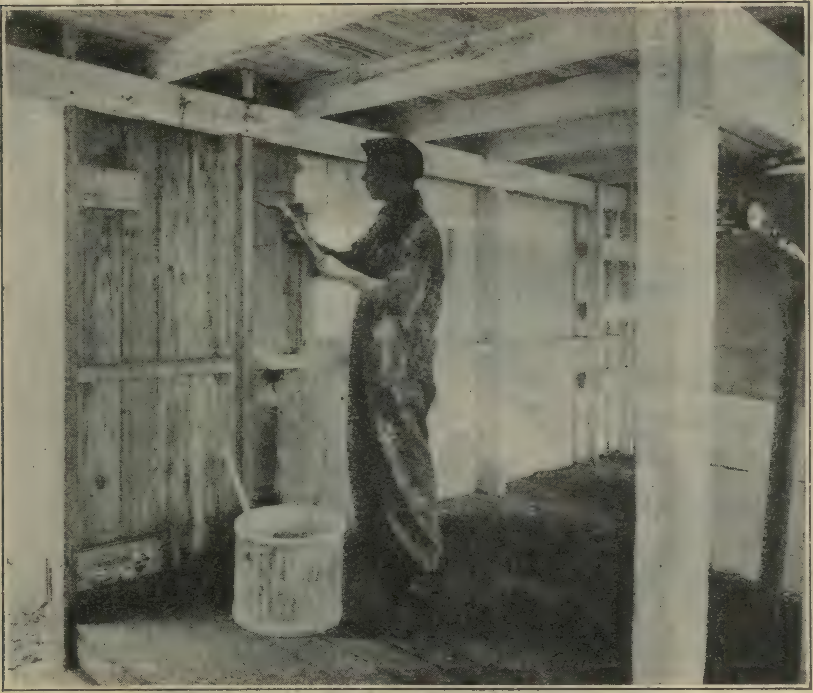

Fig. 12.—Whitewashing an old barn

It is thought good practice to let the cows out of the stable at least once a day, even if this is not necessary for the purpose of watering. The stables are more easily cleaned and bedded when the cows are out, and opportunity is afforded for convenient observation of any cows that may be in heat.

CLEANLINESS

GROOMING

No dairyman should permit his cows to remain in a dirty condition. Pride in his stock and stable should be sufficient incentive to keep his cows and stable clean. Manure or litter should not be allowed to remain on the cows, and for this reason grooming should be a part of the regular dairy work. Grooming not only adds to the appearance of cows by keeping them clean and improving the condition of their coats, but also makes possible the production of cleaner milk. Washing and carding the tails occasionally adds much to the appearance of the herd.

BEDDING

Bedding is used for three reasons: (1) To provide a comfortable bed, (2) to keep the cow clean, and (3) to absorb the liquid manure. The common bedding materials are wheat straw, oat straw, corn stover, shavings, and sawdust. The desirable qualities of a bedding material are bulkiness, large water-holding capacity, high content of fertilizing constituents, and freedom from dust which would contaminate the milk. As regards bulkiness, the straws and shredded corn stover are superior to shavings or sawdust. Experiments at the Illinois station show that 40 per cent more shavings than oat straw are required to keep the animals bedded.

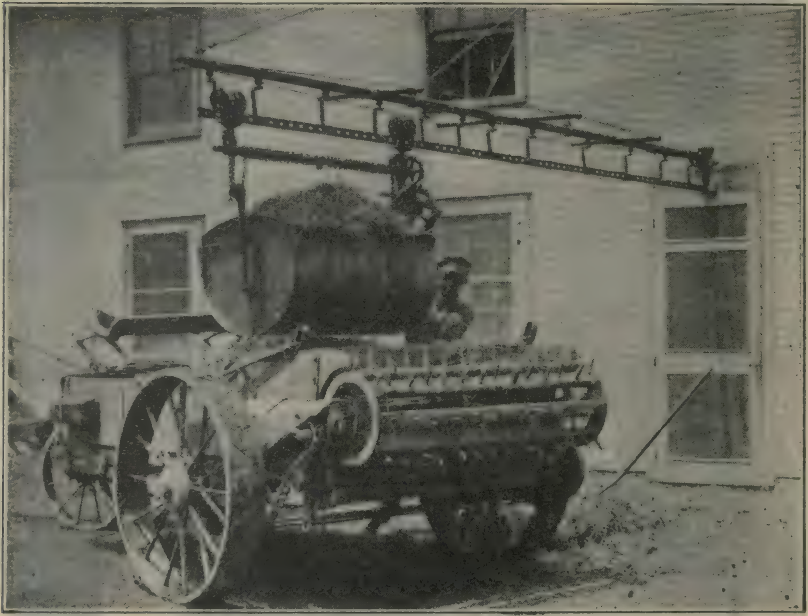

FIG. 13.—Placing manure from the barn in spreader

The water-holding capacity of various materials was determined at the Illinois station and verified by work at the Beltsville station. With dry materials they rank as follows: Shredded or cut corn stover, straw, with little choice between shavings and sawdust for last place.

The fertilizing value is greatest with the corn stover. This is followed by oat straw and wheat straw in the order named. Sawdust and shavings have only a slight fertilizing value.

Shavings are superior to other forms of bedding as regards cleanliness and for this reason are much used in dairies where very clean milk is produced. In dairies where this extra sanitation is not a matter of great importance, it appears that pound for pound shredded stover or straw is worth at least 50 per cent more than sawdust or shavings. Records at the Beltsville station show that when wheat straw is used as the bedding material, about 4 pounds per cow per day will be used by cows confined in stanchions, and about 14 pounds will be used by cows in box stalls. Although 4 pounds a day will provide a suitable bed and keep the cows clean when confined in stanchions, this quantity is not sufficient to absorb all the liquid manure; to do this, about 8 pounds per cow would be required for an average producing herd.

MANURE DISPOSAL

The advice generally given for handling manure on the dairy farm is to spread it on the land as soon as possible after it is made (fig. 13). With certain reservations this seems to be sound advice. It is questionable whether one obtains greater returns from the manure handled in this way during the winter than by proper storage, but it does give better distribution to farm labor and obviates the necessity of a building to hold large quantities of manure. Spreading manure on snow, though often advised, is a questionable practice on account of washing, especially if the land is rolling. Probably it is also inadvisable to haul manure on the fields when the ground is so soft that the wagon makes deep ruts.

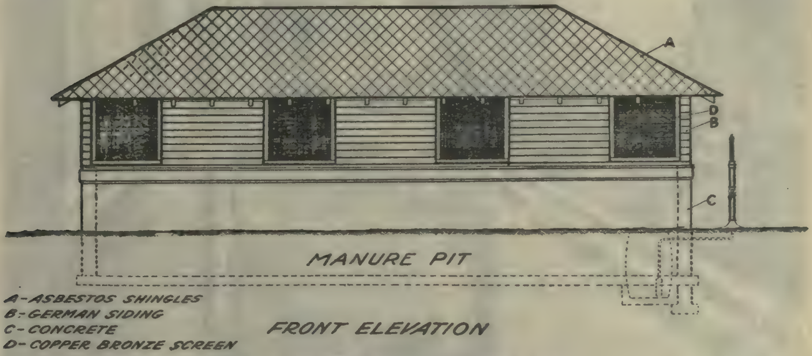

FIG. 14.—A concrete manure pit

At certain other seasons, when farm work is pressing, manure hauling must be delayed. It appears, therefore, that storage of manure can not well be entirely avoided, and a suitable storage place should be provided to prevent excessive loss of fertilizing ingredients through leaching (fig. 14). In storing manure plenty of moisture and thorough packing are the main things to consider. Where bedding is cheap, sufficient can be used to absorb the liquid manure; where it is scarce and high in price, the liquid can be drained into a cistern, or by using a water-tight manure pit the liquid can be stored with the solid manure. All manure should be removed from the stable at least once a day.

The equipment used in removing manure ranges from a wheelbarrow to a power conveyor running in the gutter behind the cows.

In dairies of medium to large size the most popular method of removing manure is the litter carrier with overhead track, such as is manufactured by several barn-equipment firms. The carrier may discharge directly into a manure spreader or wagon or may go to a manure pit. Inclosing or screening the manure pit will help in controlling the fly nuisance.

FEEDING

METHOD AND ORDER OF FEEDING

The quantities of grain to be fed should be determined for each individual cow wherever possible. A general herd mixture can be made up and proper quantities weighed out to each cow. A number of methods for feeding the grain are in use, but the most practical is to place a sufficient quantity in a truck or cart that is pushed through the feeding alley, where the quantity for each animal is weighed or measured out. (Fig. 15.) If this method is used, there may be certain cows that will need some feed not in the general herd mixture, and these can easily be fed later. There should be a feeding card or sheet available showing the quantity of feed each cow is to get. A small blackboard can be attached to the feed cart and the figures placed on this board with chalk every two or three days. A spring balance scale suspended above the cart on an arm will be of great help.

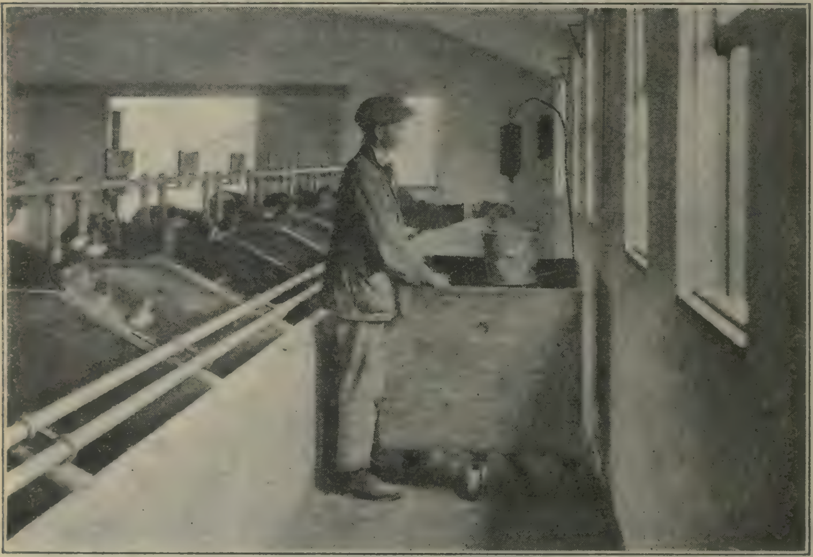

FIG. 15.—Feeding from a truck. These cows are on experiment, and the high mangers keep them from getting feed from adjacent cows

Silage can be fed from the same or a similar cart. If a scoopful of silage is weighed occasionally as a check, the quantity can be measured with a fair degree of accuracy.

Baled hay is convenient for feeding. If loose hay is fed, the hay chutes should be conveniently placed so as to require as little work as possible. The allowance of hay should also be weighed occasionally.

Feeding should be done regularly, because, as has already been pointed out, cows are probably more sensitive to change in the feeding routine than to variation in the hours of milking. Grain is usually fed first, leaving the roughage until after milking. This practice will tend to keep down the dust and dirt during milking. Silage and other feeds that might taint the milk should be fed after milking. About half the grain and roughage should be fed in the morning and half in the evening. If cows are milked oftener than twice a day, the grain feedings should correspond, but the roughage can be fed twice a day. Some dairymen feed grain on the silage.

WATER

A plentiful supply of fresh, clean water is essential on the dairy farm. (Fig. 16.) The demand for water by the dairy cow depends mainly upon the air temperature, the quantity of milk produced and of succulent feed in the ration. The quantity of water drunk in cold weather is about the same as in moderate weather, but is much less than in hot weather. If large quantities of such feeds as beets or mangels are fed, very little water is required.

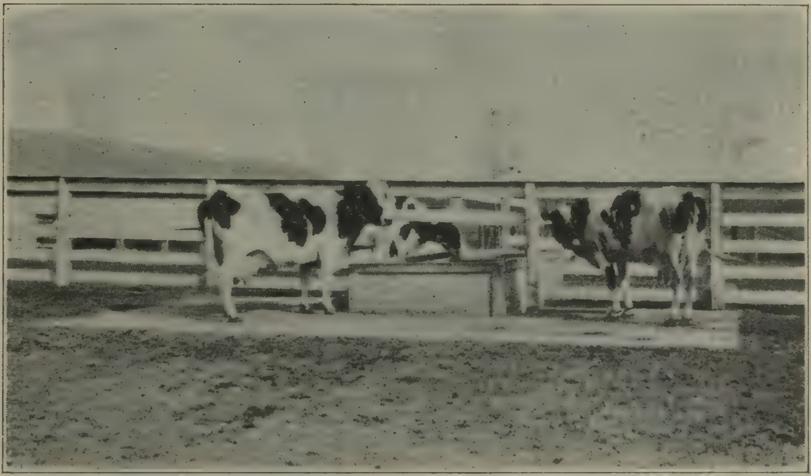

FIG. 16.—A practical concrete watering tank, accessible from three lots

In experiments at the Beltsville station cows were watered once, twice and at will from watering cups. Cows watered once a day drank less and produced less than when watered twice a day or at will. Cows watered twice a day drank as much but produced less than when watered at will. The cows used were average producers and the maximum difference found in production, between watering once a day and at will, was only about 5 per cent. The higher the production the greater the benefit to be derived from frequent watering. Some low-producing cows fed silage, hay, and grain refused to drink more than once a day in cold weather. With cows similar in production and receiving the same kind of feed, water consumption was 80 per cent greater in hot summer than in cold winter weather. The demand for water was greatest after eating hay. In cold weather cows prefer water that has been warmed and will drink more of it, though experiments at several stations show that the amount of production is influenced but little by warming the drinking water.

SALT

Dairy cows should have all the salt they want. The quantity consumed will vary with the kind of feed and size of the animal. Experiments have shown that ordinary cows in milk will require about 1 ounce of salt a day. Heavy producers should get more. Many dairymen mix salt with the grain mixture, incorporating from 1 to 2 pounds of salt with each 100 pounds of concentrates. In addition, salt is provided so that the cows can have access to it and take more if they desire. Stock salt can be purchased in several forms. In cake form, salt may be kept in each feed box in the barn where the animal can lick it, or it may be placed in convenient places in the lot or pasture. It should be in some sheltered place, to prevent the rain from dissolving it. (See fig. 17.)

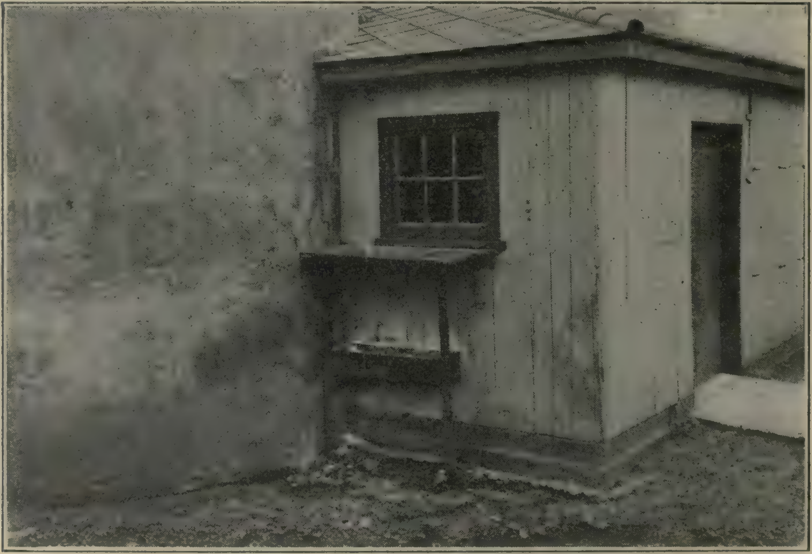

FIG. 17.—A conveniently arranged salt box

FITTING FOR SHOW

The showing of dairy cattle is very common and serves many useful purposes. It is a guide to more constructive breeding and helps to familiarize breeders with the better type of dairy cattle. Probably the most important reason for showing is the advertising that it brings. To exhibit widely is expensive and one should consider fully the benefits as compared with the cost and effort. However, the owner of a few cattle can exhibit at local shows and fairs to advantage without much trouble and expense. The following suggestions are made for his guidance.

1. Fitting cows for show should begin a year before the exhibition, for only in that way can they be made to show most advantageously. The cows can then be selected and bred so as to calve a short time before the first showing. By this plan each cow is at her best, has a large udder, and has had a few weeks in which to recover from freshening.

2. With bulls and young heifers early preparation is unnecessary. When animals are to be shown in classes under 1 year of age, it is well to choose calves that were born just after the date used in figuring age (usually August 1 and February 1) so that they may have the greatest development. Large, growthy young animals always appear to better advantage in the show ring than smaller ones.

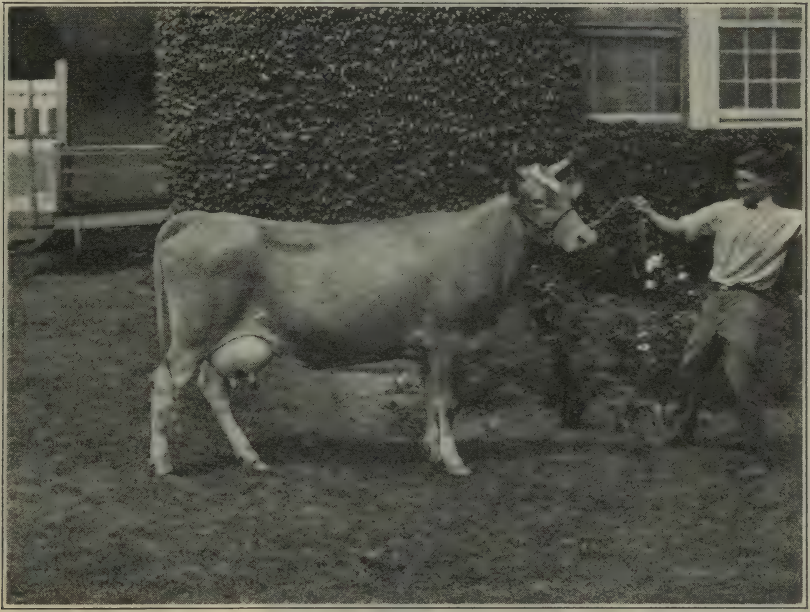

FIG. 18.—A well-fitted cow properly shown

3. Animals to be shown should be in good flesh, not fat, but smoothly covered over all parts. Thin animals in poor condition will be discriminated against in the ring. No particular system of feeding is necessary for dairy animals, but the feed should be somewhat laxative and should be fed in abundance. The teaching or training of animals to walk, stand, and act so as to appear to the best advantage, is a very essential part of fitting for show. They should be taught to walk in an alert, active manner, and, above all, they must be trained to stand erect for long periods without slouching. The training should be so thorough that practically nothing will excite the animals and make them hard to manage. (Fig. 18.)

4. For a month or two before the show the animals should be kept in the barn. After being thoroughly washed and scrubbed with soap and thoroughly rinsed, they should be blanketed with light burlap

blankets. From that time on the animals should not be allowed to remain out of doors in the sun without blankets, if their hides are to be kept mellow and soft. Clipping is an important operation, and there are many different methods. The extent of clipping depends upon the conformation of the animal and its quality of hide and hair. In any case, the face, ears, udder, milk veins, and tail should be clipped, the switch, of course, being left. Clipping gives an appearance of trimness and quality to the animal that is difficult to obtain in any other manner. (Fig. 19.) Clipping several weeks before the show allows the hair to grow out somewhat and makes the coat look softer. Much time should be spent daily in brushing, first with a stiff, coarse brush, then with a lighter, softer one, and finally rubbing with a woolen cloth moistened with linseed oil. Such treatment will bring a gloss and softness even to the coarsest hair. If the hide is thick and tight or has a tendency to be coarse, occasional scrubbings with hot suds made from green soap, followed by a heavy blanketing and sweating, will aid greatly in producing a loose, pliable skin.

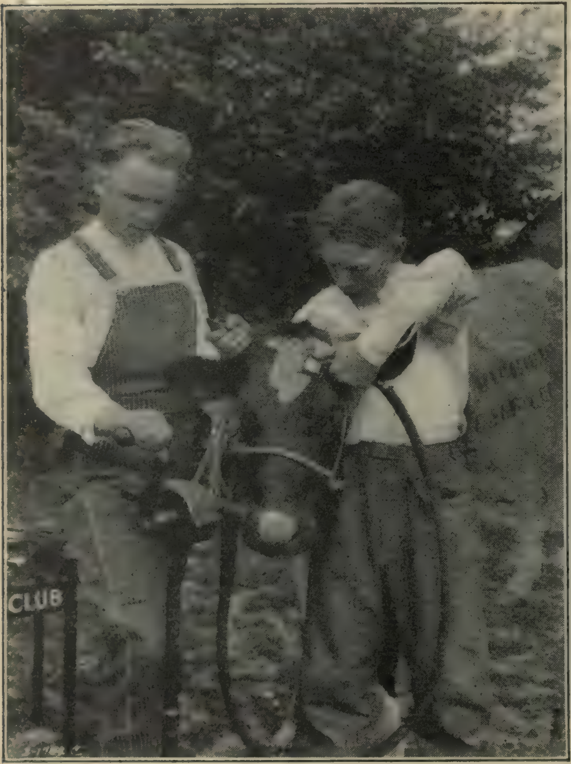

FIG. 19.—Clipping gives an appearance of trimness and quality. Note blanket on heifer

5. Hoofs must be trimmed so as to be symmetrical. (Fig. 20.) This can easily be done with a hoof knife, pincers, rasp, wood chisel, and mallet. After trimming, the hoofs should be rasped smooth. Care should be exercised in all this work not to cut or rasp the hoofs too thin. If the hoof is so hard that a hoof knife can not be used, the animal may be placed on a wooden floor and the hoof trimmed by means of a chisel and mallet. The hoof should be oiled and rubbed to a gloss after final smoothing.[7]

6. If animals have horns, these should be scraped with a steel scraper or glass lengthwise until nearly smooth and then finished off with fine sandpaper or emery cloth. When as smooth as they can

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[7] For directions and pictures on trimming hoofs and horns, see Farmers' Bulletin 1412, Care and Management of Dairy Bulls.

be made, the horns should be polished frequently before the show with powdered pumice stone and sweet oil. It is very common to make leather, chamois, or flannel horn coverings to protect the polished horns.[7]

7. The tail should be washed several times. The day before showing it can be bleached with blueing, if light in color, and then braided into three or four small braids and left overnight. When ready to show, open the braids and brush out the tail, thus giving it a clean, fluffy appearance.

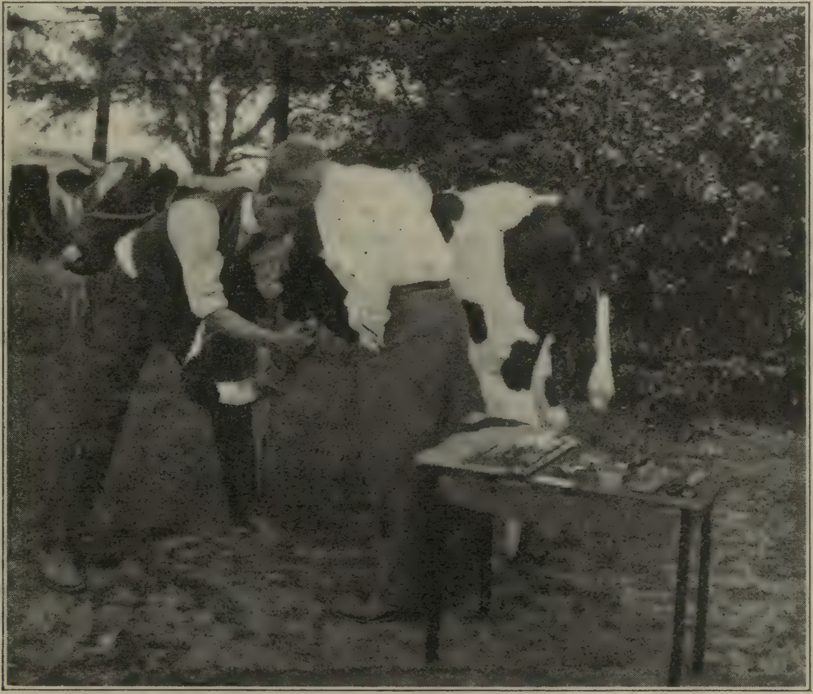

FIG. 20.—Trimming the hoofs. Note also how hair on face and ears has been clipped, and horns polished

DISEASES AND COMMON AILMENTS

TUBERCULOSIS

In most cases this infectious disease is of a chronic nature, taking a number of years to run its course, often with no visible symptoms. Consequently the more chronic its character the more dangerous as spreaders of the disease are animals affected with tuberculosis.

The disease may be introduced into a herd by bringing in diseased animals, by feeding calves milk from tuberculous cows (this may happen by using unpasteurized skim milk from a creamery), by showing cattle at fairs, by shipping cattle in infected cars, and by pasturing with other cattle that have the disease. The most reliable way to tell whether living cows have tuberculosis is to have them tuberculin tested by a competent veterinarian.

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[7] For directions and pictures on trimming hoofs and horns, see Farmers' Bulletin 1412, Care and Management of Dairy Bulls.

Of all the plans tried out for the eradication of tuberculosis, the accredited-herd plan and the accredited-area plan offer the most promise and are accomplishing the best results.[8]

INFECTIOUS ABORTION

Infectious abortion is a disease very prevalent in dairy herds and causes excessive losses to dairymen each year.

The symptoms which denote its presence in a herd are rather indefinite and inconstant. The act of abortion is probably the symptom which is most widely known and readily observed, but may easily be misinterpreted, since not all cows which abort are affected with the infectious disease. Its prompt recognition in diseased herds is rendered difficult by the fact that many animals which acquire the disease may never abort.

Cows that abort as a result of the disease often retain their afterbirths.

It has been observed that barrenness is usually a troublesome factor in herds in which the disease has gained entrance. Often cows that have aborted conceive promptly, but it is not infrequently necessary to breed an aborter five or six times before conception takes place.

The presence of the disease in herds not only causes loss of calves but may seriously interfere with milk production as well.

At the present time no specific cure for infectious abortion is known. The proper course to pursue is dependent in a measure upon how extensively the disease has spread. The disposal of aborters may afford but slight relief, since their elimination from the herd usually means that only a portion of the affected animals have been removed.

Abortion losses in infected herds may be prevented to no small degree by appropriate sanitary measures, such as (1) isolation of aborting animals or those about to abort, as long as they continue to have uterine discharges; (2) disposal of fetuses, afterbirths, and bedding contaminated with uterine discharges in such a manner that they will be inaccessible to the rest of the herd; (3) precautions against tracking discharges about premises; and (4) liberal use of disinfectants about stables.

Maternity stalls should be provided for all cows in the herd at time of calving, in which they should be confined following calving as long as they have uterine discharges. The infected cow which produces a seemingly normal calf may be as great a source of danger to healthy stock at time of calving as though she had aborted.

Experimental studies have indicated that animals acquire the disease mainly through the mouth by consuming feed or water that has been contaminated with material from the generative organs of infected animals either at or near times of calving or aborting. It is at these times, therefore, that extreme precautions should be taken in so handling the animals that their discharges may be confined to as small an area as possible, where they may be gathered up and proper disposition made of them.[9]

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[8] Detection, control, and eradication of this disease are discussed fully in Farmers' Bulletin 1069.

[9] Details of this disease and treatment can be obtained by writing to the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

DIFFICULT CALVING

Usually a cow will calve without assistance if kept quiet and not excited. Strangers, children, and particularly dogs, should be kept away from the cow. The stall or other place where the calf is to be born should be clean. Before labor has progressed to any great extent it is well to see that the presentation is normal; that is, that the front feet and nose are first to appear. Sometimes one or both feet or the head is doubled back. When this occurs, calving without assistance is difficult or impossible. The calf should be placed in proper position for it to be born, and this usually means pushing the calf back into the uterus, which is sometimes rather difficult to do. Unless a person is skilled in such work it is better to call a veterinarian. A bungled job may mean serious laceration of the uterus, a loss of the cow, or the death of the calf. Calves can also be born hind feet first. When this occurs, some one should be on hand to see that delivery is hastened at the critical moment; that is, when it has so progressed that the blood supply to the calf through the navel cord is shut off. The calf must then be able to start breathing or it will smother.

Sometimes assistance is needed, especially with the young cows, even when the presentation is normal. Hence the cow should be watched rather closely, but no help should be given unless it is necessary. Time must be allowed for the relaxation of the openings from the uterus and vagina. In general, labor should continue for two hours or more before any help is given, although the condition of the cow should be taken into consideration. She should not be allowed to become too much exhausted before help is given.

The way to help is to take hold of the calf's feet, if they protrude, otherwise pass cotton ropes around them, and pull hard every time the cow strains. Do not pull at any other time and do not be in a hurry about getting the calf. Too much haste or excessive pulling may injure both cow and calf.

As soon as the calf is born, the navel cord should be clipped about an inch from the belly, the few drops of blood squeezed out, and tincture of iodine or full-strength compound solution of cresol or other coal-tar preparation applied.

The afterbirth is usually passed in a few hours, but if not expelled naturally within two days it is thought best by most veterinarians to remove it by hand. This should not be attempted by an unskilled person, as care must be taken to avoid injury in disengaging the cotyledons which attach the afterbirth to the uterus, and special effort must be made to get all the afterbirth. It is also necessary to avoid introducing infection into the uterus by dirty hands or irrigating tube. The irrigating tube should be sterilized by boiling before and after use. Very mild antiseptic solutions, in large quantities, or salt solution (1 tablespoonful to a gallon of boiled water), are then used to flush out the uterus. If the cow does not expel all the liquid herself, it should be siphoned out. Flushing of the uterus should take place daily as long as a sterilized rubber tube can be inserted into the uterus. When the opening closes, so that a tube can not be inserted, the vagina should be flushed every day or so until all discharges cease.

MILK FEVER

This is a disease that generally attacks mature cows from the fourth to the sixth calf. High producers are more subject to it than low producers, and fat cows are more subject to it than thin cows. It nearly always occurs within two days after calving, and seems to be caused by an overfed condition of the animal. Plenty of water and salt and a minimum quantity of concentrated feed for several days before and after calving will help to prevent this disease.

The disease may be recognized by a staggering gait and lack of control of the hind legs. As the disease progresses the cow goes down in a stupor, lying in a normal position, except that her head is usually turned to her flank. Later, paralysis may become general and then the cow lies on her side.

The treatment consists of inflating each quarter of the udder with air filtered through a liquid or cotton. Almost any sort of air pump will serve to force the air into the udder. Satisfactory milk-fever outfits are on the market, or can be made up at little expense, using a bicycle pump, rubber tubing, a piece of large glass tubing in which to place the cotton, and a milk tube. Care must be exercised to have the milk tube sterile and the ends of the teats should be cleansed with a disinfecting solution. After inflation the teats should be tied with tape in order to prevent escape of the air. Ordinarily one inflation is sufficient, but in case the cow shows no improvement in two hours the inflation should be repeated. Every dairyman should keep a milk-fever outfit on hand for quick use.[10]

GARGET

"Garget," "mastitis," and "mammitis" are terms which denote inflammation of the udder. One or more quarters may become swollen, hard, hot, and tender. The milk is reduced in quantity and may be of watery consistency or contain clots or strings of curd. In severe cases the contents of the udder may become foul-smelling. Cows with large udders are more susceptible than those with small udders. Some of the conditions which seem to cause or at least predispose the animal to garget are (1) exposure to drafts or cold weather, (2) bruises of the udder, (3) injuries to the teats, (4) the use of a milk tube, and (5) excessive feeding on rich feeds. Sometimes garget seems to develop without any apparent cause. Very often a sore on the end of the teat will lead to udder infection and garget.

Treatment consists of giving a dose of Epsom salt or other purgative, and putting hot applications on the affected parts several times a day for a least 30 minutes at a time. The Epsom salt should be given as a drench. (Page 32.) After these applications the udder should be wiped dry, and camphorated oil applied and rubbed in thoroughly.[11]

COWPOX

This is an infectious disease which causes characteristic sores on the udder and teats. Tenderness and redness of the teats are first noticed, which is followed by eruption of grayish-red nodules. A vesicle or blister forms in the center of the nodule in about 10 days and in another 3 days the blister breaks, discharges a yellowish serum, and then a scab forms.

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[10] See Farmers' Bulletin 206, Milk Fever, Its Simple and Successful Treatment.
[11] See Farmers' Bulletin 1422, Udder Diseases of Dairy Cows.

Treatment consists of healing the sores left by the blisters. Zinc ointment is a very good remedy, acting not only as a disinfectant but also keeping the affected parts soft, thus preventing cracking and bleeding. Since this disease is commonly carried from one cow to another by the milkers, the affected animal or animals should be milked last; and, as a further safeguard, the hands should be disinfected after milking each cow in the herd.[12]

FOUL FOOT

This trouble is experienced in many herds. It is thought to be most frequently caused by infection from stable filth while standing in wet, dirty places, or from foreign matter becoming wedged between the claws. The hind feet are most likely to be affected. The animal seems to suffer when walking on the sore foot, and the region of the foot is inflamed and swollen. When the soreness has advanced, there may be sloughing off of the membrane between the claws, which has an offensive odor. The foot should be thoroughly cleaned, and if only slightly inflamed can be washed in a solution of carbolic acid, 1 part of pure acid to 20 parts of water. Cresol compound (liquor cresolis compositus U. S. P.), undiluted, is also good. The animal should be kept in a clean, dry place. In persistent or aggravated cases, the foot should be washed well with the solution and a wad of absorbent cotton smeared with pine tar placed in the cleft. This can be held in place by taking a strip of strong cloth, 2 inches wide, passing the middle between the claws, and then tying the ends after winding them above the hoof. The corner of a grain sack with strips left attached for tying makes a good outside bandage.

CHOKE

Choking is usually caused by a cow trying to swallow too large an object, like an apple, potato, or turnip. It may occasionally result from the collecting of soft feed into a ball. It is most likely to occur in cows that are greedy feeders.

The animal stops eating, coughs, and saliva runs from the mouth. When attempting to drink, water runs from the mouth. If the choke is high in the throat it may be felt as a lump on the left side of the neck. When the cause of the choke can be located in the throat it may be forced up into the mouth or crushed by pressing with the hand. A pint of raw linseed oil or olive oil will aid by acting as a lubricant. In severe cases a competent veterinarian should be called.

BLOAT

Bloat may be caused by any kind of feed which produces indigestion and forms gas in the paunch. It can be caused by pasturing on young clover or alfalfa, especially with the dew on, or by feeding spoiled silage, roots, etc. The paunch is inflated most noticeably on the left side. In severe cases this distention may extend above the back. When tapped with the fingers the paunch gives a drum-like sound. When bloat is pronounced, difficulty in breathing is noticed.

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[12] See Farmers' Bulletin 1422, Udder Diseases of Dairy Cows.

Exercise the animal by walking. If this does not help, give 2 tablespoonfuls of liquor cresolis compositus (U. S. P.), mixed with 2 quarts of warm water as a drench. After bloating has subsided, give 1 pound of Epsom salt in 3 pints of warm water as a drench. If these remedies are not effective, and in urgent cases where the gas must be allowed to escape without delay, it may be necessary to puncture the paunch. This is best done with a trocar and canula. The trocar is a sharp-pointed instrument which fits smoothly into a hollow tube called the canula, leaving the sharp point exposed. After inserting the trocar and canula, by a quick, firm thrust inward, downward, and forward, the trocar is pulled out and the canula left in the opening. This will allow the gas to escape. The paunch is punctured on the left side with the trocar at the center of a triangle formed by the last rib, the hip bone, and the loin.

The animal should be fed sparingly on easily digested feed for several days after bloating has stopped, so that all fermenting material may pass out of the stomach.

DRENCHING

Medicine is usually given to cattle by "drenching." This is commonly done by mixing the medicine with water and giving this by the aid of a long-necked bottle or drenching horn through the mouth. The medicine should be given slowly, to prevent choking. A simple drenching tube can be made by using an ordinary tin funnel with a piece of rubber hose.

Care must be used in drenching to prevent the medicine from passing down the animal's windpipe to the lungs, causing pneumonia. In giving a drench the head of the animal should be held in an elevated position. The mouth of the bottle is inserted at the side of the mouth in front of the jaw teeth and on top of the tongue. If the animal coughs, the head should be immediately lowered, to prevent the liquid from passing to the lungs. Care should also be taken in holding the animal, to avoid stopping breathing through the nose. Unless one has had considerable experience in this practice it is best to call a veterinarian, especially if other than ordinary medicines are to be given.

NAILS OR WIRE IN THE STOMACH

On farms where much baled hay or mill feed is used many cows are killed as a result of sharp-pointed wires or nails puncturing the wall of the stomach, piercing the heart, or setting up infection. There is one compartment of the stomach in which such material is collected and held. Most of it usually does no harm, but occasionally a sharp-pointed object reaches a vital organ with fatal results.

Some farms have provided magnets over which all ground feed is passed. Pliers are used for cutting the wire on the baled hay instead of a hatchet or ax. Since the pliers sever the wire at one cut there is less danger of short pieces of wire being broken off and mixed with the hay. If the hatchet always severed the wire at the first stroke it would be as good an instrument as any for cutting the wire, but usually more than one stroke is used.

When a cow is suffering from a nail or wire coming in contact with the heart, breathing becomes short and is accompanied usually by a gentle grunt at each respiration. The appetite and general health are also affected, and in severe cases the brisket may become swollen. The trouble is usually first noticed by general depression and refusal of feed.

Operations to remove the foreign objects have been successfully performed by skilled veterinarians. The usual treatment consists in keeping the cow as quiet as possible and avoiding the feeding of excessive quantities of roughage. Violent exercise or a greatly distended paunch may push the wire into the heart and cause death.

WARBLES

Warbles or grubs are the larval stage of the heel fly. The larva is about one-half to 1 inch in length and is whitish or brown in color. The grubs weaken cattle, causing them to fall off in flesh and milk, and also lower the value of the hide because of the holes they make in it.

Application of fly repellents during the summer is probably of little value in keeping off warble flies. When the grubs appear they cause lumps beneath the skin of the back. They should be forced out by pressure beneath the lump, or may be killed by forcing a little ointment, consisting of 1 part of iodoform to 5 parts of vaseline, into the opening of the lump. The former method is preferable, because it does not leave the dead grub beneath the skin.

LICE

The effects of lice are usually first noticed by patches of hair falling out around the tail-head or the withers. Careful examination will reveal the presence of lice. Unless the lice are killed, the animal will become thin and lose much of its hair. Young calves are especially affected. Lice are easily destroyed by a solution of standard coal-tar creosote stock dips. The strength of the solution as indicated on the container may be followed with safety. The dipping vat is the most effective means of applying the solution, but is not recommended to be used in cold weather. Lice can be destroyed on valuable or high-producing cows by hand treatment, without resorting to the dipping vat. It is no great job to go over the herd with a brush and disinfecting solution. A warm day should be selected for the work. A compressed-air or other type of sprayer can be used successfully in applying the solution.

FLIES

Flies are one of the greatest nuisances around a dairy; house flies because they contaminate the milk, and stable flies because they torment the cattle. Both are objectionable in that they soil the walls and equipment. House flies are not provided with biting mouth parts, but they may annoy cattle by feeding on eye and other body secretions. Their food is milk, soiled feed, etc. Stable flies have piercing mouth parts; their food is blood, and for this reason they are not attracted by milk. These two kinds of flies look much alike. In addition to these, there are the small black horn flies, which are especially bothersome on account of their great numbers.

Flies breed in filth or decomposing matter of various kinds, horse manure appearing to be the most favorable material for house flies, wet and rotting straw or other vegetation for stable flies, and cow manure for horn flies. Cleaning up, treating, or screening their breeding places is an effective method of combating flies. This is especially true if a large area is covered, such as a whole community. The individual farmer can do much to lessen the number of flies on his own farm, as the major part of them, under usual farm conditions, are produced there. Since flies will travel for miles, however, the effectiveness of this method depends to some extent on the distance from other favorable breeding places.

One of the most effective methods of decreasing the trouble from house flies is to keep all food away from them. See that there is no spilled milk for them to feed on; also that all soiled mangers that attract flies are cleaned. If there is nothing for a house fly to eat it will not stay around. Fly traps will catch a great number if properly baited. They will also attract flies into the barn, and for this reason it is better to set the traps outside rather than inside the buildings. Poison made by using a solution of formalin and milk in the proportion of 3 teaspoonfuls of commercial 40 per cent formalin to 1 pint of sweetened milk gives good results. In using this poison, blotting paper may be placed in the bottom of shallow pans and the paper barely covered with liquid. As the liquid dries out it should be renewed.

Since stable flies are not attracted by bait of any kind, the method of combating them is to keep them away from the stock by darkening the stable, blanketing the cattle, or using some sort of fly repellent on the animals. No repellent has yet been devised that will protect the animals for more than a few hours. A repellent composed of the following is probably as effective as any: Oil of tar, 10 parts; cottonseed oil, 10 parts; and paraffin oil, 80 parts. Although flies worry cows considerably, the presence of limited numbers does not materially affect milk production.[13]

WARTS ON THE TEATS

Sometimes warts attain sufficient size to interfere with milking. One method of removing them is to apply castor oil or pure olive oil after each milking for a week. If this treatment fails, the warts can be touched with a stick of lunar caustic and the oil applied after that. Long warts that are not too large at the base may be removed by tying a silk thread tightly around the wart near the teat and allowing it to remain until the wart drops off.

CRACKED TEATS

Sometimes a cow's teats will chap in the winter. The cause is exposure to cold when the teats are still moist. The remedy is to milk with dry hands and to see that the teats are dry when the cows are turned out in the cold. Wet milking and the sucking of calves make the teats more liable to chap. In case cracking occurs, the main treatment consists in keeping the teats soft with applications of oil or salve. This will help to protect the teats from excessive drying and continued cracking.[14]

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[13] The following Farmers' Bulletins give more detailed information: No. 734, Fly Traps and Their Operation; No. 1097, The Stable Fly; No. 1408, The House Fly.

KICKING

Kicking during milking is largely due to poor management. Many cows will kick when they are being broken to milk, and they must be carefully handled so that they will not form the habit. Sore or cracked teats will also cause cows to kick. One should never strike a cow for kicking. Such practice will get her excited and make her worse. Some animals must be restrained while being milked. This is best accomplished by placing a heavy strap or rope around the rear legs just above the hocks. Pass this strap around one leg, cross between the legs, and then around the other, drawing them close together. Unless crossed in the middle the strap will slip down when the cow struggles.

SELF-SUCKING

Every dairyman has had experience with cows that suck themselves. There seems to be no satisfactory explanation as to why they do this. To prevent the habit many devices and methods have been tried with varying degrees of success. One device may work successfully on one cow and fail on another. One method that has been used successfully is to fasten one end of a strong stick about 3 feet long to the ring of the halter, passing the stick between the front legs and fastening the other end to a ring in a strap that extends around the cow's body. This device allows the cow to raise and lower her head but prevents turning her head toward the body. Muzzles placed over the animals' noses, cradles around their necks, bits in the mouth, and various other methods have been used. Applications such as quinine or red pepper have been placed on the teats. If a cow is a confirmed self-sucker, she should be sent to the butcher unless she is especially valuable as a breeding animal.[14]

DEHORNING

Horns are of no use to the animal. It is no longer necessary for the cow to fight for self-protection or for the protection of her young. Cows with horns oftentimes injure one another in the stable or lot, and they sometimes accidentally injure the attendants. Bulls with horns are decidedly more dangerous than those without horns. There is only one excuse for allowing animals to retain horns, and that is for the sake of appearances; and it is very questionable whether a large proportion of horns as found really add to an animal's appearance. Still they do sometimes increase the selling price of an animal and may increase its chances in the show ring, and so long as these conditions exist it is advisable to let the horns remain on at least some of the purebred animals.

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[14] See Farmers' Bulletin 1422, Udder Diseases of Dairy Cows.

The main thing to consider in dehorning or in prevention of horn growth is to destroy or remove the skin from which the horn grows. In the calf this skin covers the horn button and can be destroyed by treatment with caustic soda or potash. In a few weeks thereafter this skin lies at the base of the horn and entirely surrounds it. Proper dehorning therefore includes the removal of this skin, which is accomplished by sawing or clipping the horns close to the head. Unless this skin is removed the horns will grow again and produce what are known as scurs.

The substance usually applied after removal of the horns is pine tar. This helps to keep away flies and probably assists in checking the bleeding. If bleeding persists, it can be stopped by passing a string around the horn stubs and twisting tightly over the poll. This string should be removed as soon as danger of bleeding ceases, or in about 12 hours. To avoid any trouble from flies it is best to dehorn during the late fall, winter, or early spring. Experiments indicate that the milk flow of dairy cows is not seriously affected by dehorning.[15]

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[15] Full details on dehorning may be obtained from Farmers' Bulletin 949, Dehorning and Castrating Cattle.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

March 25, 1926

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1471

CANNING FRUITS AND VEGETABLES AT HOME

THIS bulletin attempts to give in as simple form as possible the application of scientific principles to home canning of fruits and vegetables. Methods of canning are based on knowledge of the causes of food spoilage and ways of preventing it. Scientific research is constantly throwing new light on this subject, and the methods recommended in this bulletin are based on the most reliable information the department has been able to obtain.

This bulletin supersedes Farmers' Bulletin 1211, entitled " Home Canning of Fruits and Vegetables."

Washington, D. C. Issued May, 1926

CANNING FRUITS AND VEGETABLES AT HOME

By LOUISE STANLEY, *Chief, Bureau of Home Economics*

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CANNING is a method of using heat and air-tight containers to preserve food as nearly as possible in the condition in which it would be served when freshly cooked. It is a desirable and economical method of preserving many foods, by means of which their use is distributed over seasons and in places where they are not available fresh. Canned foods thus add variety and make possible a better-balanced diet at all seasons, the value of which to health can not be measured in dollars and cents.

What foods and how much should be canned depend on conditions in each household. Canning should be looked upon not as an end in itself, but as a means of preserving surplus material by the best method for a definite product in order that it may be utilized later to advantage. There is no question that to most people fruits and vegetables are more palatable fresh than canned; therefore it is wise to let the family eat an abundance in season. It is poor economy to cut down on the use of a fresh food in order to have a supply to can, but provision for a surplus for canning should be made wherever practicable by proper forethought in planting. Canning is, under these circumstances, a desirable method of preserving most fruits and many vegetables. Before canning any fruit or vegetable, however, the homemaker should consider whether any other method of preserving would be better for that particular product. It is usually unnecessary and wasteful of effort to can vegetables that may be stored, such as mature beets, turnips, carrots, sweet potatoes, parsnips, winter squash, and pumpkin, or those that may be successfully dried, like okra and large Lima beans. In some cases it may be desirable to can small quantities of such vegetables for use in the late spring and early summer, when the stored ones have deteriorated and the new crop is not yet available.

If fruits and vegetables have to be purchased for canning, their cost as compared with fresh products out of season or commercially canned goods must be considered. Canning should usually be confined to periods when fruits and vegetables are most abundant, as freshness, quality, and price are then most generally satisfactory. The growth of roadside stands and producer city markets and modern transportation facilities are marked aids in extending the season when fruits and vegetables are obtainable in the fresh state, and in insuring the delivery of these products to the consumer in suitable condition for canning as well as for immediate consumption. Freshness is an essential in products that are to be canned, particularly in vegetables.

CAUSES OF FOOD SPOILAGE

Successful canning is based on an understanding of the two following important causes for the rapid spoilage of fresh foods and on a knowledge of the methods by which this spoilage may be prevented.

First, there are present in all fresh fruits and vegetables substances called "enzymes." These enzymes bring about the normal ripening of fruits and vegetables and, unless checked, the final decay of the product. Since heating is an essential step in canning and these enzymes are easily destroyed by heat, it is only necessary to avoid the changes they may bring about in the food between the time it is gathered and the time it is cooked. This is the reason for the emphasis upon canning fruits and vegetables as soon as possible after they have been gathered.

The second and more important cause of food spoilage is the action of minute plants which are present in the air, soil, water, and, in fact, on everything. There are three groups of these plants—bacteria, yeasts, and molds. Yeasts and molds are easier to kill than bacteria and do not cause so much difficulty in canning. Many forms of bacteria are able when unfavorable conditions arise to go over into a so-called spore, a form in which they are very difficult to kill. For this reason bacteria are the chief factors to be considered in canning. If all bacteria are killed and the product is sealed steaming hot within a sterile air-tight container, the food is said to be sterilized. The application of heat to foods during canning in order to kill bacteria is called processing.

The presence of air has always been associated with food spoilage, owing to the fact that these small plants are present in the air even though they can not be seen with the naked eye. When unheated air comes in contact with food it spoils, not because of the air but because of the bacteria, yeasts, and molds it contains.

TIMES AND TEMPERATURES REQUIRED FOR DESTROYING BACTERIA

In killing bacteria by heat in canning both the degree of temperature and the length of time it is applied must be considered. A very high temperature may produce a sterile product that will keep well, but this may be at too great a sacrifice of flavor and texture. Therefore the temperature applied should ordinarily be the lowest necessary to accomplish the desired result, varying with the kinds of bacteria and with the acidity and other conditions of the juice. No growing or vegetative forms of bacteria will survive for any length of time at the temperature of boiling water (212° F.), but the spore form is killed at boiling temperature only by long-continued heating, especially if the fruit or vegetable being canned has juice that is nearly neutral or only very slightly acid. When the juices are acid, as in fruits and tomatoes, both the vegetative and spore forms of bacteria are killed more quickly at the temperature of boiling water. The bacteria that requires long-continued heating at boiling temperature may be killed more quickly at higher temperatures, such as are obtained in a pressure cooker. The necessary time of heating varies with some organisms from 6 hours at boiling temperature (212° F.) to 30 minutes at 240° F., the temperature obtained by steam under 10 pounds pressure.

The effectiveness of any given method of applying heat to kill bacteria is also influenced by the number present and the time necessary for the heat to reach every portion of the material being canned. This emphasizes the importance of thorough cleansing of the product before starting to can and the use of freshly gathered products free from decay. The distribution of heat throughout every portion of the material being canned depends upon a number of factors and can best be discussed under the detailed directions for different methods of packing and processing.

The types of organisms present vary with different foodstuffs and to a certain extent with geographical distribution. Since some of the most resistant forms of bacteria are present in the soil, any condition of growth that makes products more liable to soil contamination, as in the case of low-growing spinach, or that makes such contamination more difficult to remove, as in the case of the fuzzy string bean, increases the possibility of infection.

Since a number of cases of food poisoning have been directly traceable to botulism, the bacteria causing it have been studied in order to find the temperature and conditions necessary for destroying them. They will not grow in salt solutions where the percentage of salt is higher than 9 per cent. They are destroyed at boiling temperature if the solution is sufficiently acid. With nonacid vegetables and meats there is no assurance that they are killed at the temperature of boiling water unless the material is heated for as long as 6 hours. The heating time may be decreased very much if a higher temperature is used. This is the reason for the recommendation that meats and nonacid vegetables be canned under pressure. Special precaution must be taken in those regions where previous outbreaks of botulism or special difficulties in canning have shown the soil to be heavily contaminated with these or other heat-resisting bacteria.

TYPES OF HOME CANNERS[1]

The most common method of applying heat in home canning is by the use of the water bath. If water is boiled in an open vessel or one on which the top is not clamped down, the temperature reached is never higher than the boiling point of water. All additional heat applied goes to changing the water to steam and the water boils away. The boiling point of water at any place depends upon the atmospheric pressure, which changes with the altitude. At sea level it is 212° F., and it decreases as the altitude increases (Table 1).

TABLE 1.—*Boiling point of water at different altitudes*[1]

Altitude	Temperature of water		Altitude	Temperature of water	
Feet	° *F.*	° *C.*	*Feet*	° *F.*	° *C.*
Sea level	212	100	5,225	202	94
1,025	210	99	6,304	200	93
2,063	208	98	7,381	198	92
3,115	206	97	8,481	196	91
4,169	204	95	9,031	195	90

[1] The directions for processing in boiling water (pp. 15 to 18) are based on the boiling point at altitudes of 1,000 feet or less. For altitudes above 1,000 feet the length of processing should be increased 20 per cent for each additional 1,000 feet.

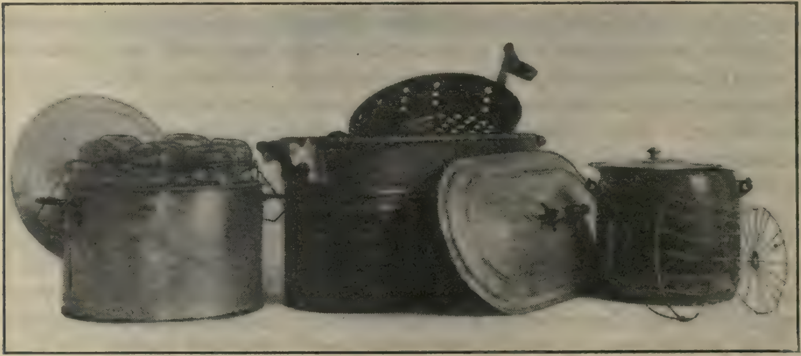

FIG. 1.—Three typical water-bath canners

WATER-BATH CANNERS

A water-bath canner (fig. 1) may be made from a wash boiler, bucket, or any vessel that has a tight cover and is large enough to hold a convenient number of jars. It should be fitted with a rack to hold the jars away from the bottom of the utensil, thus protecting them from bumping or overheating and allowing full circulation of water under them. A wire basket answers this purpose and also makes it possible to lift a large number of jars in and out of the canner at one time. Such a basket can be made by a tinner at small cost or at home from wire-mesh fencing. The water-bath canner can be used successfully for processing fruits, tomatoes, and a few other products (pp. 15 to 18).

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[1] The word "canner" is used in this bulletin for the vessel or apparatus in which the cans or jars are processed.

PRESSURE CANNERS

A pressure cooker (fig. 2) is a vessel specially designed for obtaining temperatures higher than can be reached in a water bath. It is impossible to heat water alone to a temperature higher than the boiling point at the particular altitude at which the test is made unless the vessel in which the water is heated is closed and the cover clamped down so that the steam is held in under pressure. Such vessels are known as pressure canners, pressure cookers, and autoclaves.

A pressure canner should be strongly built, and the top should clamp on tightly so that there is no leakage of steam when closed. There must be an air outlet with a pet cock, and the top should also be equipped with a pressure gauge, a thermometer, and a safety valve. Since the temperature is a measure of the pressure, it is ordinarily assumed that one can be interpreted in terms of the other. The pressure gauge, however, does not always indicate the actual temperature within the canner, and it is better to have both a gauge and a thermometer, for one then serves to check the accuracy of the other. The temperature reached in a pressure canner is in direct proportion to the steam pressure and is dependent upon the air having been completely removed. Ordinarily this is accomplished by allowing 3 minutes to elapse after steam issues from the pet cock before it is closed, or it may be assured by never completely closing the pet cock.

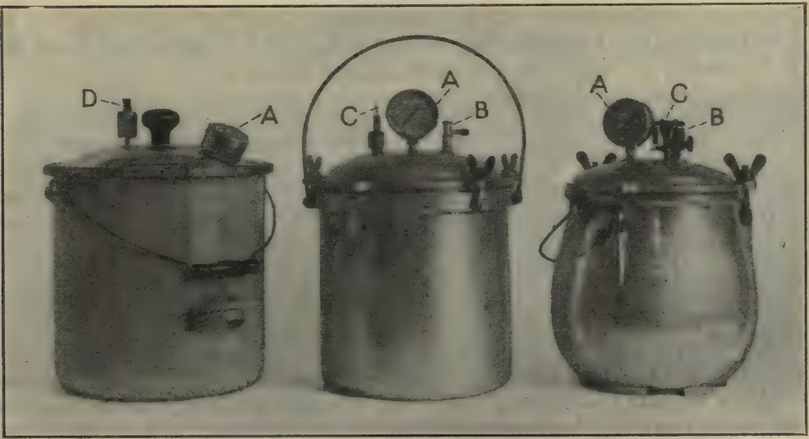

FIG. 2.—Three pressure cookers which may be used for canning small quantities: A, Pressure gauge; B, pet cock; C, safety valve; D, combined pet cock and safety valve. This should not be placed in position until air has been completely removed

In selecting a pressure canner, the above requirements should all be carefully checked. Also in size it should be suited to the kind of containers and the probable number to be handled at one time. In case the canner must be lifted on and off the stove during the canning it is also important that it should not be too heavy. The relationship between steam pressure and temperature is shown in Table 2.

TABLE 2.—*Steam pressure obtained in pressure canners and approximate corresponding degrees of temperature under standard conditions at sea level*[1]

Steam pressure	Temperature	
Pounds	° *F.*	° *C.*
5	228	109
10	240	115
15	250	121
20	259	126
25	267	131

[1] The reading of the pressure gauge is affected by altitude. For this reason it must be increased 1 pound for each 2,000 feet elevation in order to maintain the same relationship between temperature and pressure indicated in the above table. The pressures and times in the table apply from sea level to 2,000 feet. Commencing with 2,000 feet add 1 pound for each 2,000 feet elevation. In case the cooker is equipped with a thermometer the pressure reading may be disregarded and the thermometer used as an indicator of the pressure.

CONTAINERS

Containers for canned products must be so constructed that they can be sealed air-tight to prevent the entrance of air which contains bacteria, yeasts, and molds.

GLASS JARS

The containers most used for home canning are glass jars. By the purchase of new rubbers, and in some cases new tops, they can be used repeatedly. The different types vary in size, shape, and method of sealing, as shown in Figure 3.

The Mason jar has a porcelain-lined metal screw cap. .The difficulty experienced by many in cleaning this cap has led to the development of the modified form that has a glass or porcelain top held in place by a metal collar or ring which screws down over it. This collar should be made of a noncorroding metal, because if it corrodes it can be removed only with difficulty and in some cases not at all. As a precaution, when these jars are removed from the canner the metal ring may be taken off and a clean, dry one substituted.

In the wire-clamp glass-top jars the cover is a glass disk which fits down onto the rubber ring and is held in place by a wire clamp. This type of lid is very easily cleaned and sterilized, and if handled with care will last as long as the jar. The jar is easily sealed and can be opened with little difficulty, and only the rubber needs to be renewed each season.

The automatic seal jar has a lacquered metal top. Around the under surface of this is a groove filled with a hard, waxlike compound, which softens when heated and adheres to the glass. During the processing period the top is held in place by a metal spring or clamp which allows the air to escape, but holds the top to the jar, so that when the steam condenses no air is drawn in and a vacuum seal is formed. Also, as the jar cools the special compound hardens, making the seal more complete. A new lid is required each time the jar is used.

Another type of automatically sealed glass jar is being used, especially for products that are to be shipped. It is made of very heavy glass and is somewhat shorter and broader than the usual jar.

The opening has approximately the same diameter as that of the commoner types, and around the top is a heavy projecting rim over which the lid is clamped. The lid consists of a metal disk lacquered underneath, which fits inside of another metal cover. Around the edge of the inner disk is a groove, into which is fitted a gasket of rubber composition. The metal cap that fits over this disk comes down over the glass rim at the edge of the jar, and by means of a special sealing machine it is crimped around the edge and thus held securely in position. This outer metal cap prevents the seal from being broken during transportation. The lids must be renewed each season. This jar is especially adapted to steam-pressure canning, because it does not permit loss of steam or water during processing, as most glass jars do, unless they are very carefully handled.

RUBBER RINGS

An important factor in the successful use of glass jars is the rubber ring. These must be bought new each year and should be of good quality if they are to withstand the temperature of processing. During the war there was much difficulty, owing to the poor quality of rubber used. The rings now available seem on the whole to be of better quality. The simplest test is to double the rings together and press the fold with the finger. The rubber should not crack under this treatment. They should also stretch to twice their length and return without change of shape.

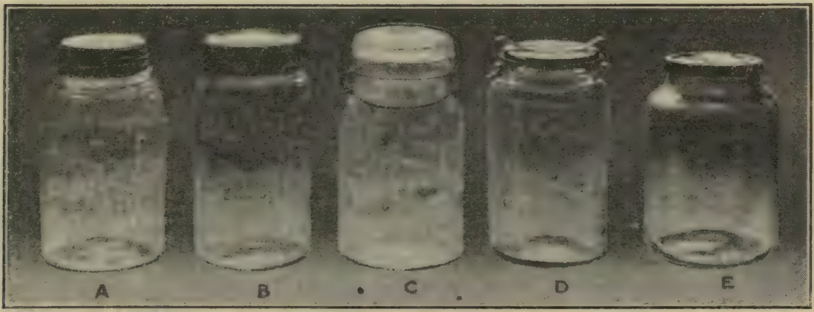

FIG. 3.—Glass jars: A, Mason; B, modified Mason; C, wire-clamp glass-top jar; D, automatic seal; E, jar requiring special sealing device

TIN CANS

For commercial and to some extent for home canning tin containers are used. They have certain advantages over glass. There is no danger of breakage, either during canning or afterwards during storage and transportation, and they are easier to handle than glass when processing under pressure. Tin cans also heat through more quickly and may be plunged into cold water immediately after processing, which, of course, is impossible with glass jars. This rapid cooling checks the cooking and produces a more desirable product. The larger opening in the newer type of can makes it easier to pack some products in cans than in jars. At least two types of tin cans are in use at present.

The first type, the cap-and-hole can, is much like the old-fashioned wax-sealed kind, except that it is sealed with solder instead of with wax. The top is provided with a circular opening which is closed by soldering a tin disk over it with a capping steel. A small hole in the center of the disk allows the air and steam to escape during the exhaust. This hole must be closed by solder before the processing period begins.

The second type of tin can in general use, the sanitary or rim seal, is rapidly replacing all others. The top is entirely open and is sealed by a double seaming of the cover onto its edge. The part of the cover which comes in contact with the upper edge of the can is coated with a compound or fitted with a rubber composition film that makes a seal when the cover is crimped on. The can is sealed with a machine, several types of which are on the market. One of the simpler machines may be adjusted to handle both No. 2 and No. 3 cans and, if desired, can be obtained to fit other sizes (fig. 14).

For use with pumpkin, squash, and beets the cans should be lacquered or enameled. This inside coating, in case it covers the metal completely, retards the action of the vegetables on the tin.

METHODS OF CANNING

In the so-called open-kettle method the material is cooked directly in an open vessel as a means of killing the bacteria. This cooking takes the place of both precooking and processing in the other methods. The food is then filled into sterilized jars and sealed immediately. The temperature is not increased above the boiling point of water, except as it may be slightly raised by added sugar or soluble materials in the juices; therefore this method is suitable only for fruits and tomatoes. The food is heated through more evenly and quickly than when it is heated after packing in jars. The disadvantages of this method lie in the necessity for the sterilization of the jars before they are filled and in the danger of contamination during filling. Furthermore, there is always danger that air containing microorganisms will be incorporated when the jars are filled in this way. If they are sealed and inverted while boiling hot, however, this danger is in part avoided.

The term "cold pack" has been applied to the method in which material was packed cold into the container and then processed either in a water bath or a pressure canner. Fruits and vegetables needing to be peeled or softened in order to be packed to advantage were "blanched" in hot water or steam and then dipped into cold water. Sirup or brine was added, usually boiling hot, but even then the temperature of the food was considerably lower than boiling, when it was placed in the canner for processing. The chief disadvantage of this method is that when the material is packed cold a longer time is required for that at the center of the can to reach the temperature of the canner. This is especially true in the case of such vegetables as corn, that are thick and pasty, or those with mucilaginous juices, for these heat through very slowly. Some fruits, however, with a large proportion of added liquid may heat through quickly and be successfully packed by this method, but the shrinkage is sometimes greater than with other methods.

HOT-PACK METHOD

The advantages of the open-kettle method and any possible advantages of the cold-pack method of canning are combined in the hot pack. In this a short precooking of the material is substituted for the usually recommended blanching, and the cold dip is omitted. The theory that bacteria are killed by the shock of cold dipping has been proved to have no scientific basis. Precooking in this sense means heating the material in a minimum quantity of liquid until it boils, the material is thoroughly wilted and shrunken so as to facilitate packing, and any inclosed air is driven out. The material is then filled into the container boiling hot and processed immediately. Containers so packed may be sealed without the usual exhaust, and the time required for the material to reach the temperature of the canner is decreased in containers of all sizes.

STEPS IN CANNING

Safe canning requires careful attention to every step in the process.

SELECTING AND PREPARING THE MATERIAL

Use only clean, fresh, sound fruits and vegetables in prime condition. "Two hours from garden to can" is a good rule. In any case for the best results material should be canned the same day it is gathered. If it must be held, discard at once any showing bruises, decay, or other imperfections, and keep the remainder in a cool place in small lots adequately ventilated.

Be sure that the containers in which fruits and vegetables for canning are gathered and handled are clean. Any unnecessary infection at this stage increases the difficulty of processing and the chances of spoilage in the finished products.

Grade for size and same degree of ripeness if a uniform product is desired.

Wash the material thoroughly until every trace of soil is gone. The most dangerous bacteria and those most difficult to kill are in the soil. A wire basket is a help in washing, but should not be loaded too heavily. Always lift the material out of water rather than pour water off.

In case a bushel or more of peaches or apricots is to be canned at one time they may be peeled with the use of lye, but this method is not justified with a smaller quantity. Be careful in using lye, especially if children are around, for it is a powerful caustic and serious accidents have happened.

To peel peaches or apricots with lye, prepare in an agateware or iron kettle, never aluminum, a solution of one-fourth pound (4 ounces or about 4 level tablespoons) of granulated lye of a standard brand in 2 gallons of water. Heat to boiling, and while actively boiling immerse the peaches or apricots in a wire basket until the skin is loosened and partially dissolved. This will usually require 30 to 60 seconds. Remove the fruit, wash it at once in running water, if possible, until skin and lye are removed, and thoroughly rinse the fruit. If still water is used, rinse the fruit in a fresh supply after washing off skin and lye.

Fruits and tomatoes may be precooked or not as desired (figs. 5 and 6). Nonacid vegetables should always be precooked to remove air, to shrink them, to facilitate packing, and to make possible packing in the container at boiling temperature (figs. 11 and 13).

While the material is being prepared the jars may be put in a water bath to boil. This serves the double purpose of cleansing the jars and of heating them, so that they may be filled with the hot material without any danger of breaking.

PACKING THE MATERIAL IN THE CONTAINERS

Pack the material in the jars or cans. If it has been precooked, work quickly so that it does not cool. Be sure that the containers are completely full, with a sufficient proportion of liquid to solids to prevent too dense a pack, and that there are no air bubbles. In case there is not enough liquor in the precooked vegetable, add boiling water, and to all vegetables add the required quantity of salt. To fruits packed cold, add boiling sirup.

SIRUPS USED IN CANNING

In canning fruits it is advisable to prepare in advance the sirup which will be needed. The degree of concentration of the sirup recommended for different fruits varies and is designated as thin, medium, and thick.

For thin sirup use 1 cup of sugar and 3 cups of water.

For medium sirup use 1 cup of sugar and 2 cups of water.

For thick sirup use 1 cup of sugar and 1 cup of water.

In each case the sugar and water are heated together and stirred carefully until the sugar is dissolved and the sirup brought to a boil. Fruit juice may be substituted for the water in the sirup with marked improvement in flavor.

ADJUSTING COVERS

Place rubbers in position on jars and adjust caps. If the jars are filled with boiling hot material they may be sealed completely before they are put into the water-bath canner, and they should always be so sealed when the pressure canner is used (fig. 12). If the material is not boiling hot when packed, the jars should be only partially sealed when put into the water bath for processing (fig. 7), according to the following directions for the various types. On the screw-top jar, screw the cap evenly about half-way down. With the wire-clamp glass-top jar, screw the cap on evenly and raise the upper clamp in position to hold the lid in place, leaving the lower clamp loose until after processing. On the automatic-seal jar, fasten the cap with the metal spring or clamp.

Seal tin cans which have been packed hot before placing them in the canner (fig. 14). When not packed boiling hot, tin cans should be exhausted before sealing, to remove the air. If cap-and-hole cans are used, adjust and seal the caps, but do not seal the holes until after exhausting. Lids should not be adjusted on sanitary cans until after exhausting.

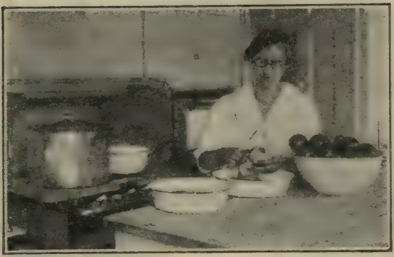

FIG. 4.—Make the sirup and put the jars on to sterilize while the fruit is being prepared

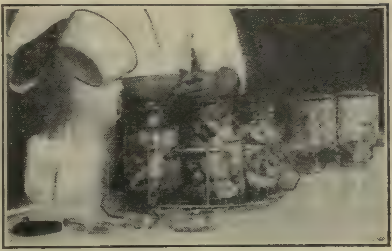

FIG. 5.—Pack the fruit in the jars and cover with boiling sirup

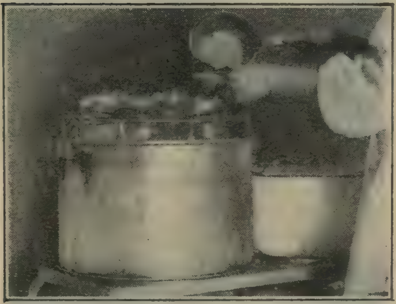

FIG. 6.—Or precook the fruit and fill it into the jars boiling hot

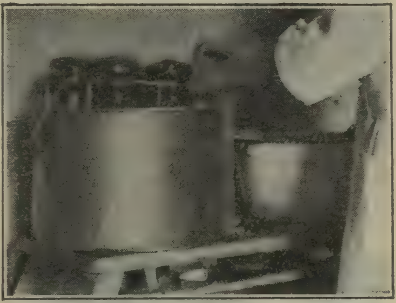

FIG. 7.—Place the rubbers in position and adjust caps (p. 10)

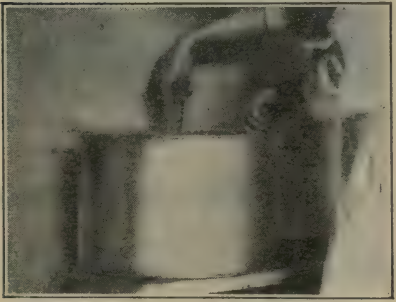

FIG. 8.—Process for the time indicated in the table (p. 18). If not sealed before processing, seal spring caps before removal from the water bath by pushing down the lower wire as illustrated, and tighten screw-cap jars immediately on removal from the water bath

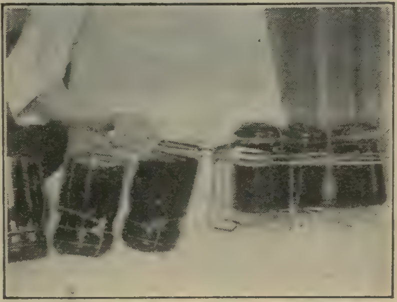

FIG. 9.—Invert the jars while cooling so as to test for leaks. Allow them to cool quickly to room temperature in a place protected from drafts, and keep them under observation for at least a week

EXHAUSTING

The air should be removed as completely as possible from the material being canned before it is sealed in the container. This step is called "exhausting." In the case of glass jars packed with food below boiling temperature, exhausting is done during processing, since they are not sealed air-tight when placed in the canner. There are special devices on the market to exhaust glass jars before sealing. However, since they are normally exhausted as a part of the heating process, it seems questionable whether the extra effort is justified. In tin cans and glass jars packed boiling hot the head space is filled with steam and further exhaust is unnecessary. Heat all other tin cans in water or steam bath until steaming hot, in order to drive out air; then seal immediately.

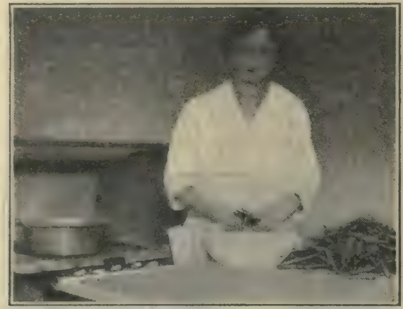

FIG. 10.—Prepare the vegetable as for cooking and precook as directed (pp. 19 to 20). If glass jars are to be used, put them on to boil

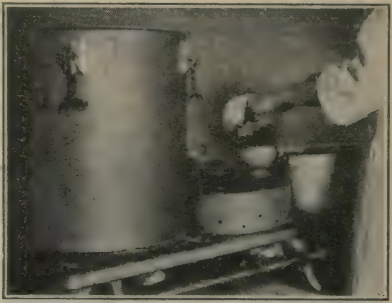

FIG. 11.—Fill the jars with the vegetable boiling hot

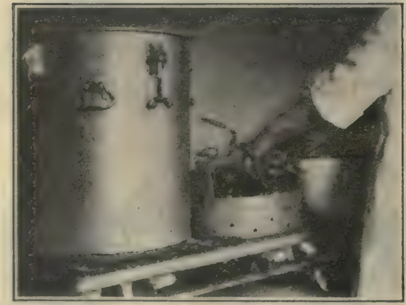

FIG. 12.—Place rubbers in position, adjust caps, and seal completely while boiling hot

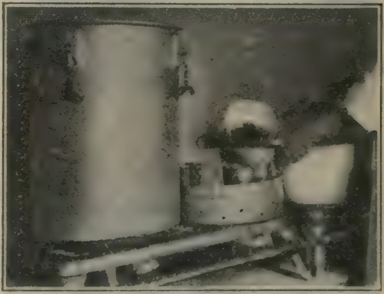

FIG. 13.—Or fill the tin cans with the boiling hot vegetable

PROCESSING

Heating material to kill the bacteria is called "processing." Process at the temperature and for the time indicated in tables on pages 18–21. Observe the following precautions in using glass jars and tin cans in water-bath and pressure canners.

With the water-bath canner.—Be sure that the jars or cans are far enough apart and that the rack on which they are supported is so arranged that the water can circulate freely under and around them.

Have the water in the canner boiling before putting in any jars or cans. The glass jars must be hot either from preheating in water or from filling with hot material in order to prevent breakage.

When all the containers are in the canner, see that the level of the water comes over the tops.

Count time as soon as the water begins to boil vigorously.

As soon as the processing time is up remove the jars or cans from the water. If the jars were not sealed completely before processing, seal wire-clamp jars before removal from the canner (fig. 8), and all other jars immediately afterward. Invert all glass jars (fig. 9) and place them so that they will cool quickly to room temperature. Plunge tin cans at once in cold water (fig. 17).

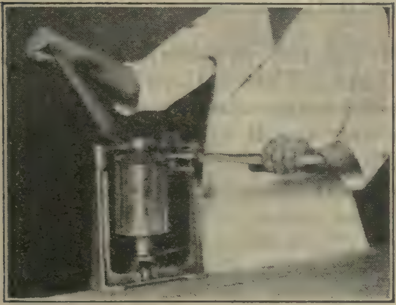

FIG. 14.—Seal the cans immediately while the head space is filled with steam

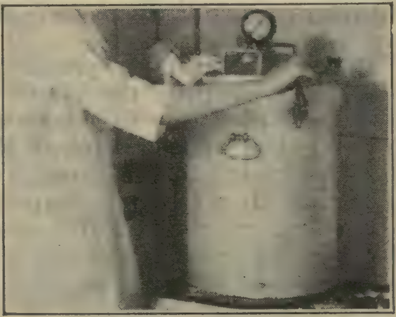

FIG. 15.—Place the filled containers in the pressure canner. Adjust the cover, but do not close the petcock until steam has escaped for at least 3 minutes. Bring the pressure quickly to the desired point and hold it there for the time indicated in the table (p. 21). Watch carefully and adjust the heat so that the pressure will be kept at the desired point

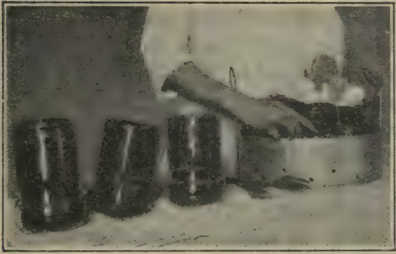

FIG. 16.—If glass jars are used, open the canner cautiously (p. 14). Invert the jars immediately upon removal. Allow them to cool to room temperature and keep them under observation for at least a week

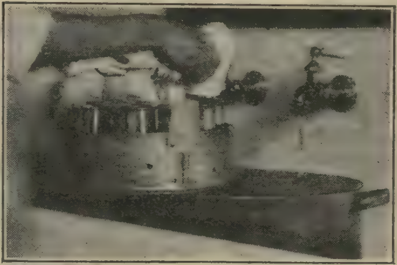

FIG. 17.—If tin cans are used, the canner may be opened more quickly. Plunge the cans into cold water immediately upon removal from the canner

With the steam-pressure canner.—Pour boiling water into the canner until the level is just below the rack that holds the jars. Be sure that there is enough to prevent boiling dry during processing.

When the canner has been filled, adjust the cover and fasten securely. In case the cover is fastened by several clamps fasten moderately tight those opposite each other, one pair at a time; then go back over the whole set and tighten each pair (fig. 15).

See that no steam escapes anywhere except at the pet cock.

Allow the pet cock to remain open until steam escapes from it in a steady stream for at least 3 minutes, indicating that no air remains inside.

Then close the pet cock so that only a trace of steam can escape. Some persons prefer to close the pet cock entirely, particularly with small canners in which a great loss of steam is to be avoided because of the danger of boiling dry.

Allow the pressure to rise until the gauge registers the pressure that indicates the desired temperature.

Count time from the moment the desired temperature and pressure are reached.

Maintain a uniform pressure during the processing period by regulating carefully the source of heat. Fluctuations in pressure, as from 10 pounds to 15 pounds and down again, are to be avoided in any case, and when canning in glass may result in loss of liquid. A sudden drop in pressure through cooling or release of steam may also cause this. It is especially important to avoid having the pressure go so high that the safety valve releases the steam suddenly, nor should the steam be allowed to escape suddenly by opening the pet cock.

At the end of the processing period remove the canner from the fire and proceed according to the following directions adapted to jars or cans:

When canning in glass jars, allow the canner to cool until the steam gauge registers zero before opening the pet cock, and even then open cautiously. This is to prevent too sudden a drop in pressure, which would cause the liquid to blow out of the jars, even though already sealed. Invert the jars (fig. 16), allow them to cool as quickly as possible to room temperature, and do not stack them while they are still hot.

When canning in tin, open the pet cock wide at once and allow the steam to escape rapidly. Remove the cans from the canner and plunge them into cold running water if possible (fig. 17), or if this is not available change the water as soon as it becomes warm. The more rapidly the cans are cooled the less danger there is of overcooking the product. Watch carefully for air bubbles that indicate imperfect sealing. Leakers should be opened, the contents heated and repacked in other cans, and processed again as at first.

CHECKING UP RESULTS

Mark all canned products so that those in each batch can be distinguished. Examine the inverted glass jars for signs of leakage. Hold canned products at room temperature for a week or 10 days, where they can be examined at least once a day to be sure that they are keeping. If the contents of any jars or cans show signs of spoilage, examine all of that lot carefully. After this observation period, store the canned goods in a cool place. A short storage at rather high temperature serves to bring out quickly defects that might not be noticed if the products were stored at a lower temperature. Results can thus be checked up and methods improved.

Destroy all foods showing any sign of spoilage, taking the precautions indicated on page 22. Do not taste food to determine whether or not it is spoiled. All canned vegetables except tomatoes should be boiled before tasting.

DIRECTIONS FOR PREPARING AND PROCESSING FRUITS, TOMATOES, PICKLED BEETS, AND PIMIENTOS

The times given for processing in boiling water apply only to places with altitudes of 1,000 feet or less. For all altitudes above 1,000 feet the time should be increased 20 per cent for each additional 1,000 feet.

When half-gallon glass jars are used, 5 minutes should be added to times given for pint and quart glass jars.

Apples.—Apples should be pared and cut into the sizes desired. If the pieces must stand, place them in a mild salt solution (one-fourth cup salt to 1 gallon water) to prevent them from turning dark. They may be packed directly into jars and covered with boiling-hot thin sirup. Process quart and pint glass jars for 15 minutes in boiling water and No. 2 and No. 3 tin cans for 10 minutes.

Apples packed raw shrink in canning so that the containers are not full. This can be prevented if they are boiled for 5 minutes in the sirup before packing. In this case fill into the cans hot, cover with sirup boiling hot, and process containers of all sizes for 5 minutes in boiling water.

Apples may also be baked as for serving, adding sugar to taste and water if necessary. Pack hot in the containers, cover with hot sirup, and process containers of all sizes for 5 minutes in boiling water.

Windfall or green apples may be made into sauce. Pack boiling hot and process immediately containers of all sizes for 5 minutes in boiling water.

Apricots.—Same as peaches.

Berries.—Gather the berries in shallow vessels so as to prevent crushing, and can them as soon as possible after gathering. Sort the fruit and use the smaller and any imperfect berries for the preparation of juice to use in making a sirup of medium sweetness. Wash carefully and remove caps and stems. Pack the fruit in containers, pressing it gently into place; cover with the prepared medium sirup boiling hot. Process quart and pint glass jars for 20 minutes in boiling water, and No. 2 and No. 3 tin cans for 15 minutes.

Some berries shrink so much during processing that the containers are not well filled and the berries tend to float. This can be prevented by precooking the berries before filling the containers. To each pound of berries add one-fourth to one-half pound of sugar, according to the sweetness of the fruit. Place in a kettle and heat to boiling, stirring gently, and boil for 5 minutes. Pack boiling hot and process immediately containers of all sizes for 5 minutes in boiling water.

Cherries.—Cherries may be canned pitted or unpitted, depending upon personal taste and the way in which they are to be served. If used unpitted they should be pricked to prevent shrinkage. They may be packed in hot containers and covered with boiling sirup, using thick sirup for sour cherries and medium for sweet. A better flavor will be obtained if the sirup is made from the juice which collects on pitting the cherries. Process quart and pint glass jars for 25 minutes in boiling water, and No. 2 and No. 3 tin cans for 20 minutes.

When pitted cherries are used, they may be precooked by boiling for 5 minutes with sugar to taste. In this case fill into the containers boiling hot and process immediately containers of all sizes for 5 minutes in boiling water.

Currants.—Same as berries.

Figs.—Figs are ordinarily preferred in a richer sirup than is usual for canning. For this reason they are more nearly a preserved than a canned product. Sprinkle 1 cup of soda over 6 quarts of sound, firm figs, and add 1 gallon of boiling water. Allow the figs to stand in this soda bath for 5 minutes.

Drain and rinse thoroughly. Bring 2 quarts of medium sirup to the boiling point, and add the well-drained figs. Allow the fruit to boil in this sirup for one hour. Remove the fruit carefully, pack in hot containers, fill with boiling hot sirup, and process immediately containers of all sizes for 5 minutes in boiling water.

Gooseberries.—Use the method suggested for berries packed raw, substituting a thick for a medium sirup. Process quart and pint glass jars for 20 minutes in boiling water and No. 2 and No. 3 tin cans for 15 minutes.

Or, if desired, prepare a sauce by adding a small quantity of water to the berries after they have been sorted and washed, and boiling until the fruit is cooked to a pulp. To each quart of this pulp add one-half cup of sugar or more if preferred. Heat until the sugar is dissolved, and while boiling hot pack in jars. Process containers of all sizes for 5 minutes in boiling water.

Peaches.—Before preparing fruit make thin sirup, or richer if desired. Put in one cracked peach pit for every quart of sirup. Boil for 5 minutes and strain.

Immerse the peaches in boiling water for about one minute or until the skins will slip easily, plunge at once into cold water for a few seconds; remove the skins, cut the peaches into halves, and discard the pits. Or use the lye solution method of peeling (p. 9). Pack at once, placing the halves in overlapping layers, the concave surface of each half being downward. Fill up the containers with boiling sirup. Process quart and pint glass jars for 25 minutes in boiling water if the fruit is fairly firm and hard, or for 20 minutes if it is ripe and tender. Process No. 2 and No. 3 tin cans for 15 minutes.

Pears.—Peel, cut in halves, core, and cook in boiling medium sirup for 4 to 8 minutes, according to the size of the fruit. This precooking makes hard varieties of pears pack better. Pack the pears hot into containers and fill them up with boiling sirup. Process containers of all sizes for 20 minutes in boiling water.

Pineapples.—Peel and core, remove all eyes carefully. Cut into convenient cross sections, pack into the containers, and fill up with thin boiling sirup. Process quart and pint glass jars for 30 minutes in boiling water and No. 2 and No. 3 tin cans for 25 minutes.

Plums.—Plums are ordinarily canned whole, and they should be gathered just as they are commencing to ripen. After they are washed prick each plum to prevent the skin from bursting. Fill into jars and cover with boiling medium sirup. Process quart and pint glass jars for 20 minutes in boiling water and No. 2 and No. 3 tin cans for 15 minutes.

Or, if preferred, prepare sauce by cooking the plums with sugar to taste until the sugar has dissolved. The pits and skins may be strained out or not as desired. Fill the containers boiling hot, and process all sizes for 5 minutes in boiling water.

Rhubarb.—Select young, tender stalks. Trim and wash carefully, cut into one-half inch lengths, pack into the containers, and cover with boiling hot thick sirup. Process quart and pint glass jars for 20 minutes in boiling water and No. 2 and No. 3 tin cans for 15 minutes.

Another method is to cut the rhubarb in half-inch lengths, add one-fourth as much sugar as rhubarb by measure, and bake until tender in a covered dish. Pack this sauce boiling hot, and process immediately containers of all sizes for 5 minutes in boiling water.

Strawberries.—Strawberries contain so much water that the canned product is not very attractive. They are ordinarily more palatable if preserved. The following method is recommended in case they are to be canned: To each quart of berries add 1 cup of sugar and 2 tablespoons of water. Boil slowly for 15 minutes and let stand overnight in the kettle. In the morning reheat the mixture to boiling, fill into the containers hot, and process all sizes for 5 minutes in boiling water.

Tomatoes.—Select firm, ripe tomatoes of medium size and uniform shape. Do not use tomatoes which are overripe or parts of which are spotted or decayed. Put into trays or shallow layers in wire baskets and dip in boiling water for about a minute, according to ripeness. Remove and plunge quickly into cold water for an instant. Drain at once, and core and peel promptly. Pack into jars or cans as closely as possible. For home use, fill with a thick tomato sauce or with the juice of other tomatoes; but if the tomatoes are to be sold under Federal regulations add only the juice which drains from them during peeling and trimming. Season with 1 teaspoon of salt per quart. Process quart and pint glass jars for 45 minutes in boiling water and No. 2 and No. 3 tin cans for 35 minutes.

Pickled beets.—Select beets of uniform size, cut off the stems, allowing at least 1 inch to remain on the beets so that they will not bleed and lose color and sweetness. Wash them well and cook in a covered pan until tender, in enough water to cover. For young beets this will require about one-half hour. When tender plunge into cold water, remove the skins, and when cool cut in dice or thin slices. Fill the beets into jars and to each pint add one-half teaspoon of salt. Fill up the jars with a mixture of vinegar and brown sugar in equal proportions by measure, heated to boiling, so that the sugar is thoroughly dissolved. If this is too acid, the vinegar may be diluted one-fourth with water. Process immediately containers of all sizes for 30 minutes in boiling water. Pickled beets may be processed in the water bath because of the high percentage of acid.

Pimientos.—The fruit of these peppers has very thick flesh, tough skin, and is comparatively smooth and free from ridges. They should be ripe, sound, and free from bruises. Use only whole peppers. The skin separates if they are exposed to dry heat, as in roasting, or if immersed in hot cooking oil. To accomplish this, they may be dipped in hot cooking oil (290° F.) for 2 or 3 minutes, or placed in a hot oven (450° F.) for 6 or 8 minutes. Cool quickly by dipping in cold water. The skins should then come off readily. The peppers so obtained are soft and pliable and can be folded into the cans after removing stems and seed cores. No liquid is added, since the processing brings out a thick liquor which almost covers them in the can. Add one-half teaspoon of salt to each pint. Process pint glass jars for 40 minutes in boiling water and No. 1 or No. 0 tin cans for 30 minutes.

TIME-TABLE FOR CANNING FRUITS, TOMATOES, PICKLED BEETS, AND PIMIENTOS

The times given for processing in boiling water apply only to places with altitudes of 1,000 feet or less. For all altitudes above 1,000 feet the time should be increased 20 per cent for each additional 1,000 feet.

When half-gallon glass jars are used, add 5 minutes to times given for pint and quart glass jars.

Product	Method of treatment before processing	Processing period in boiling water	
		Pint and quart glass jars	No. 2 and No. 3 tin cans
Apples	Slice, quarter, or halve, then pack in containers and cover with boiling sirup.	15 minutes	10 minutes.
	Or boil whole in sirup, or bake as for serving, and cover with sirup, and pack hot.	5 minutes	5 minutes.
	Or pack hot in form of apple sauce	5 minutes	5 minutes
Apricots	Same as peaches.		
Blackberries Blueberries Dewberries Huckleberries Logan blackberries Raspberries	Pack in containers. Fill with boiling hot, medium sirup.	20 minutes	15 minutes.
	Or precook and pack hot	5 minutes	5 minutes.
Cherries	Pack in containers, cover with boiling sirup, using thick sirup for sour cherries, and medium for sweet.	25 minutes	20 minutes.
	Or remove pits, add sugar as desired, bring to boil, and pack.	5 minutes	5 minutes.
Currants	Same as berries.		
Figs	Sprinkle 1 cup of soda over 6 quarts of figs. Add 1 gallon of boiling water. Allow figs to stand in this 5 minutes. Drain and rinse well. Add 2 quarts boiling medium sirup. Boil for 1 hour. Fill in containers. Cover with hot sirup.	5 minutes	5 minutes
Gooseberries	Pack in containers. Fill with boiling hot, thick sirup.	20 minutes	15 minutes.
	Or prepare sauce, using sugar as desired. Fill hot.	5 minutes	5 minutes.
Peaches	Scald, dip into cold water, and peel. Cut into size desired, removing pits. Fill containers, then add sirup of desired consistency, in which one cracked peach pit for every quart of sirup has been boiled.	20 minutes for ripe fruit, 25 minutes for firm fruit.	15 minutes.
Pears	Pare and cook for 4 to 8 minutes in boiling medium sirup. Pack hot in containers and fill with the boiling sirup.	20 minutes	20 minutes.
Pineapples	Peel, core, remove eyes. Cut into convenient cross sections. Pack in containers. Fill with boiling thin sirup.	30 minutes	25 minutes.
Plums	Prick. Fill in containers. Cover with boiling medium sirup.	20 minutes	15 minutes.
	Or bring to boil, using sugar as desired. Fill hot into containers.	5 minutes	5 minutes.
Rhubarb	Cut in half-inch lengths. Add one-fourth as much sugar as rhubarb by measure. Bake until tender in covered baking dish. Pack in hot containers.	5 minutes	5 minutes
	Or pack uncooked with boiling sirup	20 minutes	15 minutes.
Strawberries	To each quart add 1 cup of sugar and 2 tablespoons of water. Boil slowly for 15 minutes. Let stand overnight in the kettle. Reheat to boiling. Fill containers hot.	5 minutes	5 minutes.
Tomatoes	Scald and peel. Pack whole or cut in pieces. Cover with hot tomato juice. Add 1 teaspoon salt to each quart.	45 minutes	35 minutes.
Pickled beets	Precook, peel, and slice in containers. Cover with mixture of vinegar and sugar, boiling hot.	30 minutes	30 minutes.
Pimientos	Heat in hot fat or oven to loosen peel. Peel and pack in small containers. Add one-half teaspoon salt to each pint.	40 minutes pint glass jars.	30 minutes No. 1 or No. 0 tins.

DIRECTIONS FOR PREPARING AND PROCESSING NONACID VEGETABLES

The water-bath canning method has been widely used in the canning of nonacid vegetables as well as fruits and tomatoes. Apparently there is considerable variation in the time required for processing under different conditions of latitude, altitude, and climate, and for that reason the United States Department of Agriculture does not present directions or a general time-table for canning nonacid vegetables by the water-bath method. Because of spoilage difficulties and the risk of poisoning from occasional contamination with botulinus bacteria when nonacid vegetables are canned by the water-bath method, the department recommends the canning of such vegetables with the steam-pressure canner. Where it is not practicable to use the steam-pressure canner, times and methods to be used should be obtained from the specialist at the State college of agriculture.

Asparagus.—Asparagus for canning must be fresh and tender. Pick over carefully, discard any imperfect pieces, sort according to size, and wash thoroughly. Tie in uniform bundles, place in a saucepan, with boiling water over the tough lower portion only, cover tightly, and boil for 4 to 5 minutes; or cut in half-inch lengths, add enough water to cover, and boil for 2 minutes in an uncovered vessel. Pack boiling hot into containers, cover with the water in which boiled, and add 1 teaspoon of salt to each quart. Process immediately at 10 pounds pressure, or 240° F., quart glass jars for 40 minutes, pint glass jars for 35 minutes, and No. 2 and No. 3 tin cans for 30 minutes.

String beans.—Pick over carefully, string, wash thoroughly, and cut into pieces of desired size. Add enough boiling water to cover and boil for 5 minutes in an uncovered vessel. Pack in containers boiling hot, cover with the water in which boiled, and add 1 teaspoon of salt to each quart. Process immediately at 10 pounds pressure, or 240° F., quart glass jars for 40 minutes, pint glass jars for 35 minutes, and No. 2 and No. 3 tin cans for 30 minutes.

Lima beans.—Only young and tender Lima beans should be canned. The older ones may be dried successfully. For the young, tender ones use the method suggested for peas. Process the hot-packed beans immediately at 10 pounds pressure, or 240° F., in quart glass jars for 60 minutes, pint glass jars for 55 minutes, and No. 2 and No. 3 tin cans for 50 minutes.

Baby beets.—Only young, tender beets should be canned, and the turnip-shaped varieties make a more attractive product. Wash thoroughly and scald in boiling water or steam for about 15 minutes until the skins slip easily. Leave on at least 1 inch of the stems and all of the roots during this cooking to prevent bleeding. Slip off the skins, fill into the containers, add 1 teaspoon of salt to each quart, and fill with hot water. Process immediately at 10 pounds pressure, or 240° F., quart glass jars for 40 minutes, pint glass jars for 35 minutes, and No. 2 and No. 3 tin cans for 30 minutes.

Pickled beets may be processed in the water-bath canner (p. 17).

Corn.—The garden varieties of corn are the best for canning. They should be gathered about 17 to 25 days after silking, the exact time depending upon variety and season. Shuck, silk, and clean carefully. Cut from the cob without precooking. Add half as much boiling water as corn by weight, heat to boiling, add 1 teaspoon of salt and 2 teaspoons of sugar to each quart, and fill boiling hot into containers. Process immediately at 15 pounds pressure, or 250° F., quart glass jars for 80 minutes, pint glass jars for 75 minutes, and No. 2 tin cans for 70 minutes. Corn should not be canned in No. 3 tin cans, because of the difficulty of heat penetration.

Greens, including spinach.—Pick over the greens, discarding any imperfect leaves and tough, fibrous stems. Wash carefully in running water or through a number of waters, lifting the greens out each time. Steam or heat the greens in a covered vessel until completely wilted, adding in the latter case just enough water to prevent burning. Pack boiling hot into the containers, taking care that the material is not packed too solidly and that there is sufficient liquid to cover, adding boiling water if necessary. Add 1 teaspoon salt to each quart.

Process immediately at 10 pounds pressure, or 240° F., quart glass jars for 90 minutes, pint glass jars for 85 minutes, and No. 2 tin cans for 80 minutes. Greens should not be canned in No. 3 tin cans, because of the difficulty of heat penetration.

Okra.—Only young, tender pods should be canned. The older pods should be dried. After the pods are washed cover with water and bring to a boil. Pack hot in the containers and add 1 teaspoon of salt to each quart. Process immediately at 10 pounds pressure, or 240° F., quart glass jars for 40 minutes, pint glass jars for 35 minutes, and No. 2 and No. 3 tin cans for 30 minutes.

Peas, green.—Use only young, tender peas. Shell, discarding any imperfect peas, and wash. Bring to boil in water to cover. Pack boiling hot into the containers, and add 1 teaspoon of salt to each quart. Process immediately at 10 pounds pressure, or 240° F., quart glass jars for 50 minutes, pint glass jars for 40 minutes, and No. 2 and No. 3 tin cans for 30 minutes.

Peas, black-eyed.—Same as Lima beans.

Sweet potatoes.—Where sweet potatoes can be stored successfully, only enough should be canned to take care of the season during which the stored potatoes are not available. If in harvesting more are cut with the plow than can be used immediately, they may be canned in order to save them. In case they are canned at harvesting time it is important that the precooking be slow in order to develop the sugar in the potatoes.

Wash the potatoes thoroughly and boil or steam until the skins slip off readily. Peel, run through the food chopper quickly, so as to keep as hot as possible, and pack hot in the containers. Process immediately at 10 pounds pressure, or 240° F., quart glass jars and No. 3 tin cans for 60 to 70 minutes, and pint glass jars and No. 2 tin cans for 50 minutes.

TIME-TABLE FOR CANNING NONACID VEGETABLES WITH THE PRESSURE CANNER

Pack vegetables as nearly boiling hot as possible, using additional boiling water if necessary. Add 1 teaspoon salt to quart to all vegetables, and 2 teaspoons sugar, if desired, to corn. Place jars or cans in hot canner as soon as they are filled.

Product	Method of treatment before processing	Processing period in pressure canner		
		Quart glass jars	Pint glass jars	No. 2 and No. 3 tin cans
Asparagus	Tie in uniform bundles, place in saucepan with boiling water over lower tough portion, cover tightly, boil 4 to 5 minutes, and pack hot into containers. Or cut in half-inch lengths, bring to boil in water to cover, and pack hot into containers.	40 minutes at 10 pounds pressure, or 240° F.	35 minutes at 10 pounds pressure, or 240° F.	30 minutes at 10 pounds pressure, or 240° F.
Beans, string	Heat to boiling with water to cover. Pack hot into containers.	40 minutes at 10 pounds pressure, or 240° F.	35 minutes at 10 pounds pressure, or 240° F.	30 minutes at 10 pounds pressure, or 240° F.
Beans, Lima	Can only young and tender beans, using method suggested for peas.	60 minutes at 10 pounds pressure, or 240° F.	55 minutes at 10 pounds pressure, or 240° F.	50 minutes at 10 pounds pressure, or 240° F.
Baby beets	Can only young tender beets. Scald in boiling water or steam until the skins slip easily. Skin and pack hot into containers.	40 minutes at 10 pounds pressure, or 240° F.	35 minutes at 10 pounds pressure, or 240° F.	30 minutes at 10 pounds pressure, or 240° F.
Corn	Cut off without precooking. Add half as much boiling water as corn by weight, heat to boiling, and pack hot into containers.	80 minutes at 15 pounds pressure, or 250° F.	75 minutes at 15 pounds pressure, or 250° F.	70 minutes at 15 pounds pressure, or 250° F.[1]
Greens, including spinach.	Steam or heat in covered vessel until completely wilted, using just enough water to prevent burning. Pack hot into containers, taking care that the material is not packed too solidly and that there is liquid to cover.	90 minutes at 10 pounds pressure, or 240° F.	85 minutes at 10 pounds presure, or 240° F.	80 minutes at 10 pounds pressure, or 240° F.[1]
Okra	Can only young, tender pods. Cover with water and bring to boil. Pack hot into containers.	40 minutes at 10 pounds pressure, or 240° F.	35 minutes at 10 pounds pressure, or 240° F.	30 minutes at 10 pounds pressure, or 240° F.
Peas, green	Use only tender young peas. Bring to boil with water to cover and pack hot into containers.	50 minutes at 10 pounds pressure, or 240° F.	40 minutes at 10 pounds pressure, or 240° F.	30 minutes at 10 pounds pressure, or 240° F.
Peas, black-eyed.	Same as Lima beans			
Sweet potatoes.	Boil or steam until skins slip off readily. Peel quickly and pack hot into containers.	60 to 70 minutes at 10 pounds pressure, or 240° F.	50 minutes at 10 pounds pressure, or 240° F.	No. 2 cans 50 minutes and No. 3 cans 60 to 70 minutes, at 10 pounds pressure, or 240° F.

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[1] Should not be canned in No. 3 cans because of difficulty of heat penetration.

EXAMINATION OF CANNED FOOD BEFORE USE

It is important that all canned food be carefully examined before using. Spoilage is frequently indicated by the exterior of the can or jar. In tin cans both ends should be flat or curved slightly inward. Neither end should bulge or snap back when pressed. All seams should be tight and clean, with no traces of leaks. In glass jars the cover, if of metal without porcelain lining, should be firm and flat or curved slightly inward, as suggested in the case of tin cans. There should be no sign of leakage around the rubber ring or elsewhere. The contents should appear sound, and the liquid should be no more cloudy than when the material was first canned.

When the can is opened there should not be any sudden outrush of air or spurting of liquid. Smell the contents at once. The odor should be characteristic of the product. Any "off" odor probably indicates spoilage. At this stage examine any material which has been canned in tin to see whether it appears sound and normal in color. Examine the inside of the can. It should be smooth and clean, or well lacquered, not extensively blackened or markedly corroded.

The two types of spoilage most frequently occurring are "swells" and "flat-sours." Both these are easily distinguished, the swells by the bulging of the ends of the tin or the outrush of gas, and the flat-sours by the sour odor. A third type of spoilage, that due to the presence of *Bacillus botulinus*, is more difficult to detect. If the spores of this bacterium are not killed during canning but germinate in the closed container, a toxin or poison is formed that is very deadly. In some cases this organism may develop and form this poison with very little indication of spoilage in the food, and death has resulted from even a taste to determine whether the product was suitable for use. When present in small quantities, this toxin is destroyed by boiling, and it is therefore recommended that all canned vegetables and meats be boiled for at least 10 minutes before they are tasted. In case the liquid in the container is not sufficient to cover add boiling water. Smell the hot food carefully, since boiling brings out odors not noticeable in cold canned foods.

Canned products showing signs of spoilage should always be destroyed. If the botulinus toxin should be present, it will poison animals as well as humans; therefore every precaution should be taken to see that any spoiled canned goods are disposed of safely. If buried, it should be so deep that it can not be scratched up by chickens or dogs. Boiling with a generous tablespoonful of lye for each quart will destroy both toxin and bacteria.

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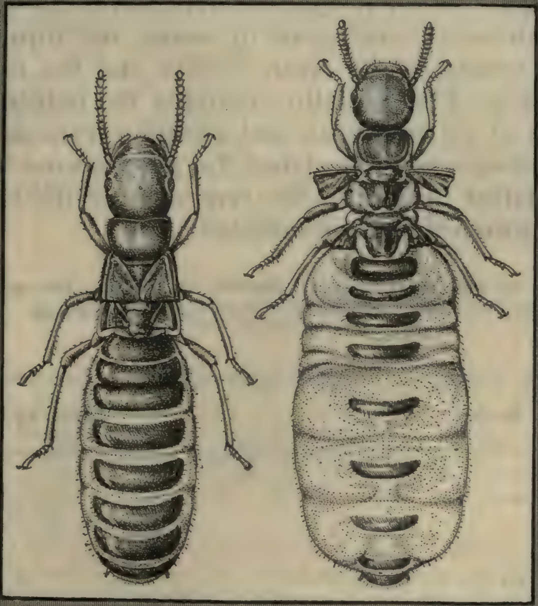
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1472

PREVENTING DAMAGE BY TERMITES OR WHITE ANTS



THROUGHOUT the United States native termites, or white ants, cause serious damage to the foundations and woodwork of buildings and articles in the buildings, as well as to living fruit and other trees, crops, and other vegetation. Such damage can be prevented by the proper construction of buildings and by chemical treatments of wood, and injury to growing vegetation by clean culture and the use of insecticides. This bulletin describes the habits and activities of subterranean and nonsubterranean termites and sets forth in detail the precautions to be taken against them and the remedies available for damage which they have inflicted.

This bulletin supersedes Farmers' Bulletin 1037, White Ants as Pests in the United States and Methods of Preventing Their Damage.

Washington, D. C. **Issued April, 1926**

PREVENTING DAMAGE BY TERMITES OR WHITE ANTS

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TERMITES AND THEIR HABITS

DISTRIBUTION AND FORMS

TERMITES, or "white ants," are destructive native insects of which 42 species occur in the United States. They are distributed throughout the country, although in the southern, southwestern, and Pacific coast regions, where both the subterranean and nonsubterranean kinds occur (fig. 1), they are more numerous and injurious than elsewhere.

These so-called white ants are not true ants, although they are superficially antlike and live in colonies made up of different forms or castes. In these nests or colonies both wingless and winged mature individuals are produced. The brownish or blackish, elongate, slender, antlike, colonizing, sexual adults (fig. 2) with long white wings, unlike the other forms, have functional eyes and their bodies are able to endure full sunlight. These migratory males and females appear normally once a year during a short period. There are three stages in the life of white ants: The egg, the immature form (nymph), and the mature individual (including sterile workers (fig. 12, *b*), soldiers (fig. 12, *a*), and the various fertile reproductive forms).

LOCATION OF COLONIES OR NESTS

The nests of some species of termites[1] are in the earth and in dead and decaying wood. These species are of subterranean habit, timber and trees being attacked by the workers only through the ground. The nests of some other species,[2] however, are excavated in wood and trees by the winged forms, there being no workers and no underground life.

With the clearing of land and the consequent destruction of their natural breeding places in the dead trees, decaying stumps, and logs of the forests, termites become increasingly destructive to the woodwork and contents of buildings (figs. 3–9), telephone poles, fences, or any timber in contact with the ground, as well as to living vegetation, including not only fruit and shade trees, shrubs, and flowers, but also truck (fig. 10) and field crops and, in California, grapevines. The principal food of termites is cellulose, which they obtain from either dead or living vegetation.

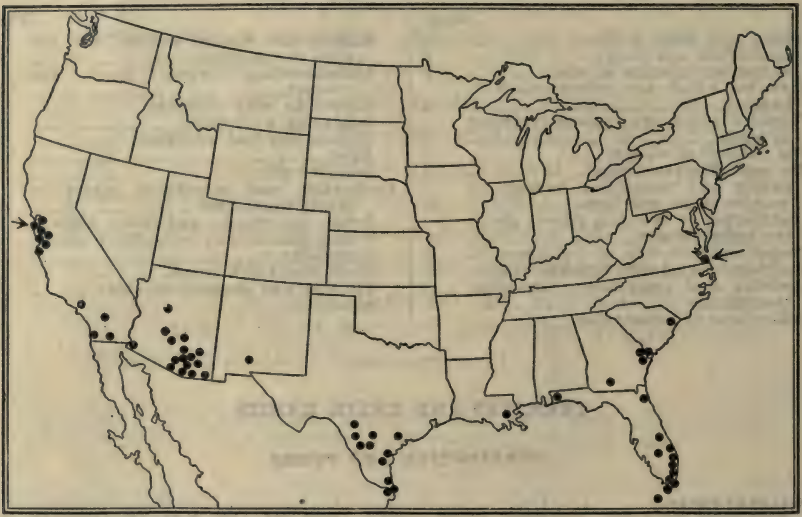

FIG. 1.—Map showing distribution in the United States of nonsubterranean wood-boring termites (Kalotermes and Cryptotermes). The dots indicate localities from which the Bureau of Entomology has records of occurrence or damage. The group of termites of subterranean habits (Reticulitermes, etc.) is much more widely distributed, being represented in practically every part of the United States

Termites in the United States are mainly species of subterranean or wood-boring habit and are not so spectacular or common as the mound-making or tree-nesting termites of the Tropics. Very few termites in this country have habits which make them conspicuous, or come above ground into the sunlight, except during the annual colonizing swarm; hence they largely escape notice until they become injurious.

TERMITES WHICH ARE SUBTERRANEAN IN HABIT

Subterranean termites live in forests, building their nests in the wood of standing timber, logs, or stumps, in cleared land, any wood in contact with the ground or, in the plains, in a labyrinth of underground passages in the earth, usually underneath wood or vegetation.

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[1] Genera Reticulitermes Holmgren, Leucotermes Silvestri, Amitermes Silvestri, etc.
[2] Genera Kalotermes Hagen, Neotermes Holmgren, Cryptotermes Banks, etc.

Termites are soft-bodied and always conceal themselves within wood, in the earth, or within their earthlike carton shelter tubes (fig. 11). The grayish-white, soft-bodied, wingless, sterile "workers" (fig. 12, *b*) are in reality the destructive form. These workers make the excavations occupied by the colony and enlarge and extend them as the colony increases. They live underground or within the wood, are blind, and shun the light; as a result they are rarely seen. In burrowing through wood the workers often completely honeycomb it, usually following the grain and eating out the softer, thin-walled, larger-celled spring or new wood. They are able to penetrate the hardest of woods, provided they have access to moisture in the ground. In extending their galleries in wood and vegetation, subterranean species carry moisture with them by means of moist excrement mixed with earth.

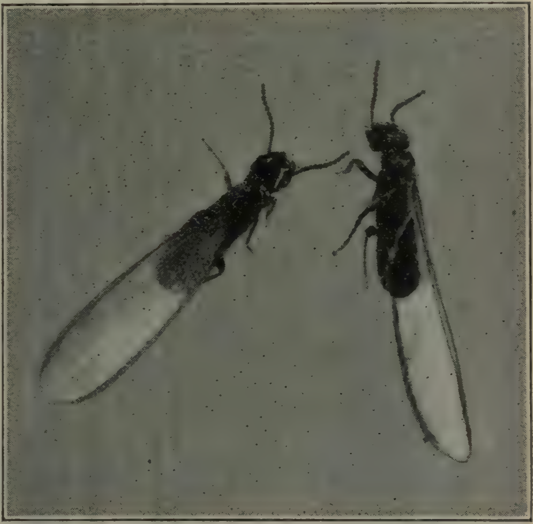

FIG. 2.—Winged sexual adults of an eastern subterranean termite, *Reticulitermes virginicus*. Nearly six times natural size

TERMITES WHICH ARE NONSUBTERRANEAN IN HABIT

The nonsubterranean termites which are injurious attack wood directly; but, instead of following the grain continuously, they excavate through it longitudinal chambers of limited length. The sexual adults, after they have lost their wings, and the young or nymphs, are the destructive forms. Their pellets of excrement (fig. 13) are regularly impressed, and sometimes completely fill or block up the burrows in a compact mass; they are often expelled as dry droppings from the infested wood. These termites are destructive to the woodwork and furniture in buildings (figs. 14, 15), as well as to living trees. Apparently they can exist without the great amount of moisture necessary to the life of termites which are subterranean in habit.

THE COLONIZING SWARM

At certain seasons, usually spring or fall, but varying with the species and the locality, the winged, sexual individuals migrate in large numbers from the parent nests. They then lose their wings and breed new colonies. In the case of the subterranean termites, wood and trees are usually entered indirectly through the ground, although sometimes these insects enter trees under bark loosened by sunburn, etc., or through scars or borer holes, provided sufficient moisture is present. Nonsubterranean termites enter the wood directly, or, in the case of trees, through wounds or borer holes or under loose bark; moisture is not necessary.

In the new quarters eggs are laid, the young develop, and in a few years the colony increases in numbers, and the "workers" are able to feed and care for the reproductive forms—the "king" (title page, left) and "queen" (title page, right)—as well as the soldiers (fig. 12, *a*), which are sterile forms adapted to protect the colony from insect enemies, notably the true ants. In recently formed young colonies the rate of egg laying is slow, but mating is repeated, and, although there is at first a gradual increase, later the increase in the numbers of the broods is rapid. In old colonies there are thousands and tens of thousands of individuals.

Egg laying occurs over a considerable period during the warm months in colonies out of doors. In infested buildings artificially heated, where an even temperature is maintained, the insects are active and may lay eggs every month of the year. The number of eggs laid depends on age.

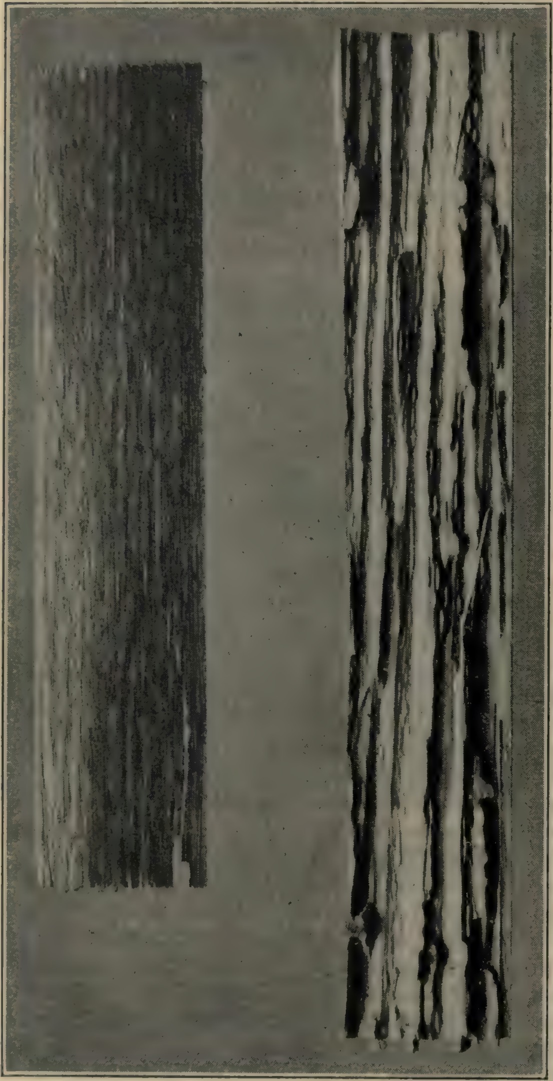

FIG. 3.—Damage to oak flooring by the common eastern subterranean termite *Reticulitermes flavipes*. Note that damage is not apparent on upper surface

THE REPRODUCTIVE FORMS

Owing to the increasing number of eggs that develop within her, the queen becomes enlarged, but never loses the power of locomotion. It was once believed that, since the queen mother was the source of the colony life, the termite colony would be exterminated if she were destroyed, but this has been disproved by more recent studies. In addition to the forms that have shed their wings, several different types of reproductive forms occur—forms with wing pads (the undeveloped wings of the nymphs) and wingless reproductive adults. The winged forms, however, are the normal type and occur as a single pair, whereas there may be hundreds of the other forms heading colonies. The reproductive forms with wing pads and the wholly wingless type usually have little color to the body, and the eyes are small. These forms rarely come above ground or leave the burrows in wood.

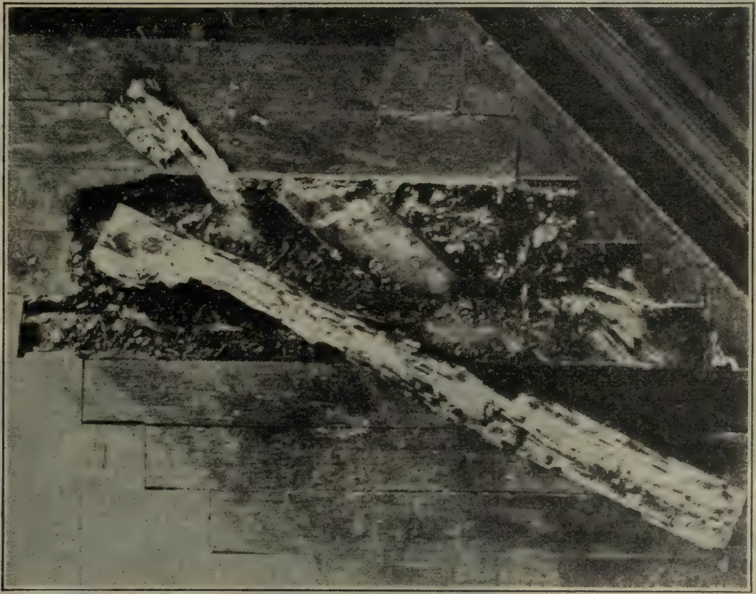

FIG. 4.—Quartered-oak flooring damaged by the subterranean termite *Reticulitermes flavipes* in an infested building, Washington, D. C., 1915

The location of the queens in the colony depends upon the season of the year. During periods of intense heat or drought in the plains or in arid or prairie regions the subterranean termites burrow deeply below ground or to a less depth under stones, cow chips, etc. During winter in the colder climates they burrow below the frost line.

Whole colonies of subterranean termites migrate when conditions become unfavorable. The nonsubterranean termites, on the other hand, are not able to leave the wood in which they have excavated their nests.

PREVENTING AND REMEDYING DAMAGE TO WOODWORK OF BUILDINGS

DESTRUCTION OF BREEDING PLACES ABOUT THE BUILDING SITE

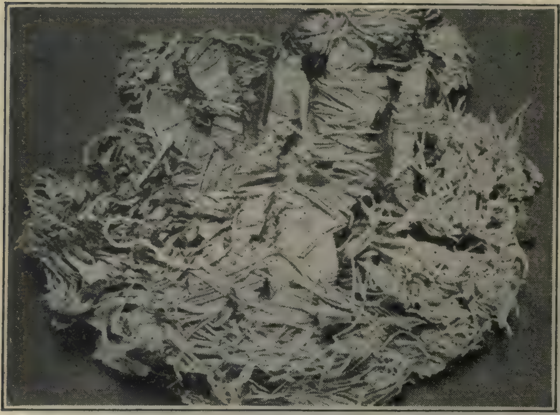

FIG. 5.—Tube of coarse yarn from bale of cotton on floor of building infested by subterranean termites, Greenville, S. C.

If buildings are to be constructed on recently cleared woodland, decaying logs and stumps should be removed from the soil in the vicinity and burned. If, because of the presence of decaying wood and humus, the subterranean termites are numerous in the earth, the soil should be deeply plowed or otherwise broken up and treated with chemicals to kill the insects. Effective poisons for this purpose are sodium cyanide;[3] a 10 per cent solution of sodium arsenite; kerosene oil; 1 part coal-tar creosote and 3 parts kerosene oil (this mixture should be strained through burlap before use); carbon-disulphide emulsion, which is on the market ready for use; orthodichlorobenzene; lye; or other contact poisons or gases. Live steam forced into the soil will serve the same purpose as the gases. Decaying fence posts, sidewalks, etc., should be removed and replaced with treated wood, concrete, stone, or other resistant substances; such decaying material would facilitate the formation or perpetuation of the termite colonies.

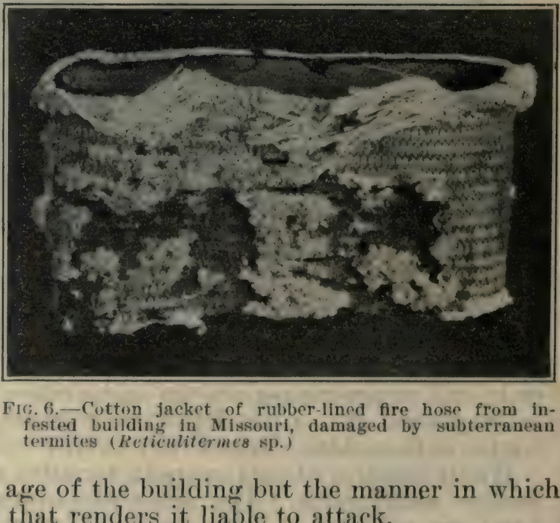

FIG. 6.—Cotton jacket of rubber-lined fire hose from infested building in Missouri, damaged by subterranean termites (*Reticulitermes* sp.)

PROPER CONSTRUCTION OF BUILDINGS

Termites will infest not only old buildings but also improperly constructed new buildings, and these are often badly infested. It is not the age of the building but the manner in which it has been constructed that renders it liable to attack.

Insulation.—Complete insulation from the ground of all untreated woodwork of buildings is the only effective permanent remedy

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[3] For each acre to be treated, dissolve 160 pounds of granular sodium cyanide in 12,000 gallons of water.

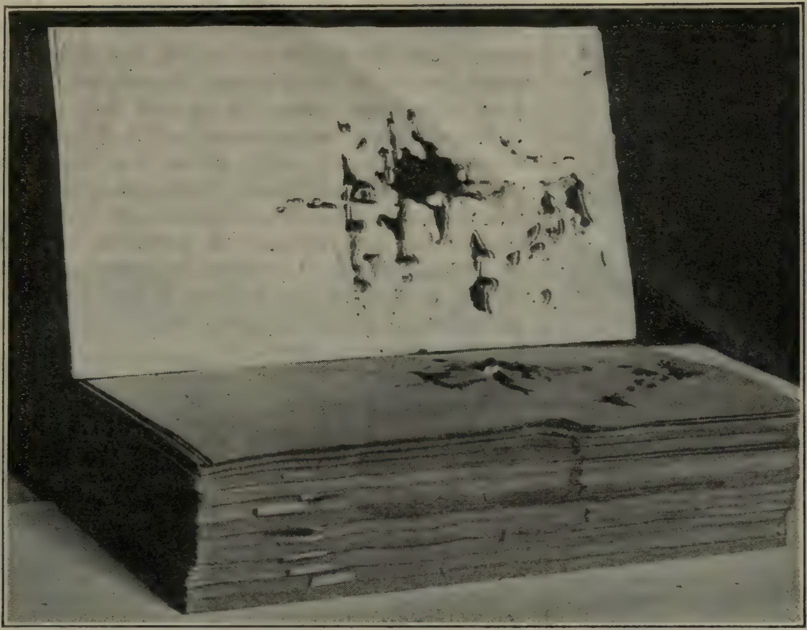
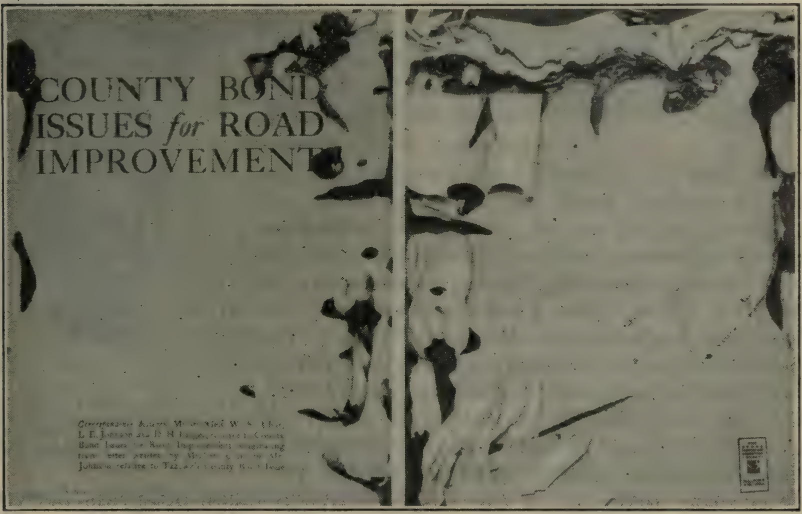


FIG. 7.—Revenue stamps damaged by the subterranean termite *Reticulitermes flavpies* on infested flooring in the Bureau of Engraving and Printing, Washington, D. C., 1921



COUNTY BOND
ISSUES *for* ROAD
IMPROVEMENT

FIG. 8.—Correspondence and advertisement regarding issue of county bonds; damaged by subterranean termites infesting the building in Virginia in which they were stored

against attack by subterranean termites, and the only relief from their presence. These insects must maintain contact with the ground to obtain the moisture necessary for their existence. When contact with their moisture supply in the earth is cut off, the subterranean insects in the damaged wood, no matter how numerous, soon dry up and die.

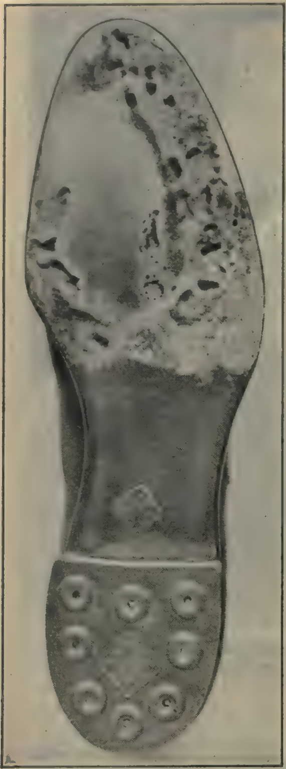


FIG. 9.—Damage by the subterranean termite *Reticulitermes flavipes* to shoe stored on infested woodwork in a building in New York City

Foundations, supports, etc.—To prevent subterranean termites from reaching the woodwork of buildings from their nests in the ground, the foundations of buildings should be constructed, if possible, entirely of stone, brick, concrete, or concrete and steel,[4] including the pillars in the basement or cellar. The walls, partitions, and flooring in the ground floor, basement, or cellar should also be of concrete. Wooden flooring can be laid over this concrete floor if desired. If the flooring is to be of concrete, the concrete should be laid on a gravel base.

In buildings where stone, brick, or concrete foundations are impracticable, timber impregnated with coal-tar creosote should be employed, and no untreated wood should come in contact with ground which may be infested with termites. Wood to be protected from termites should be impregnated with coal-tar creosote by either the cylinder-pressure or the "open-tank" process. Full details regarding these processes can be obtained from the United States Forest Products Laboratory, Madison, Wis. The open-tank process is simpler, can be made to give satisfactory results where properly used, and can be operated by unskilled labor. If for any reason neither of the foregoing processes can be used, three coats of hot coal-tar creosote brushed on the wood, with sufficient intervals between brushings to permit each coat to dry, will be fairly effective. This

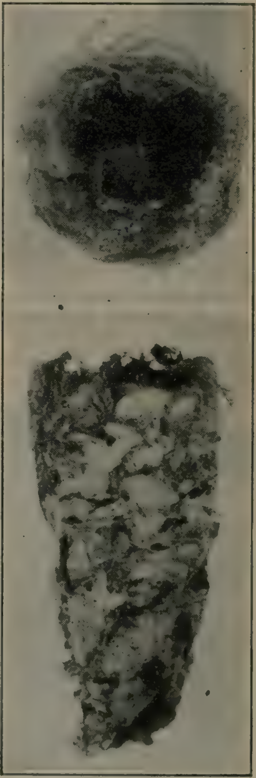


FIG. 10.—Injury to carrots by the subterranean termite *Reticulitermes claripennis,* at Dallas, Tex.

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[4] In the Southern States, especially in the subtropics, the more valuable permanent buildings should be constructed entirely of steel and concrete.

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method, however, is not generally recommended, since it will preserve the wood for only a few years.

The supports of porches or steps should never be laid directly on the ground, but should rest on rock or concrete. Window sills and frames in the basement or cellar should be laid over concrete and the woodwork should not come in contact with the ground. The supports of the woodwork of coal bins in basements or cellars should not be set in the ground, but should rest on concrete, not extending through the concrete into the soil.

Concrete flooring.—Even in permanent stone or concrete and steel buildings the concrete flooring is often constructed improperly. Usually the base of the concrete floor is a loose combination of coarse gravel or cinders and cement grout. This very rough conglomerate, even if several inches thick, has many cracks and large holes running through it. Over this is laid a layer of solid concrete about 2 or 3 inches thick, of fine texture, in which untreated wooden sleepers are laid while it is still moist. These sleepers nearly or quite reach the coarse, open conglomerate in contact with the earth, and to them is nailed the wooden flooring. (Fig. 17, A.)

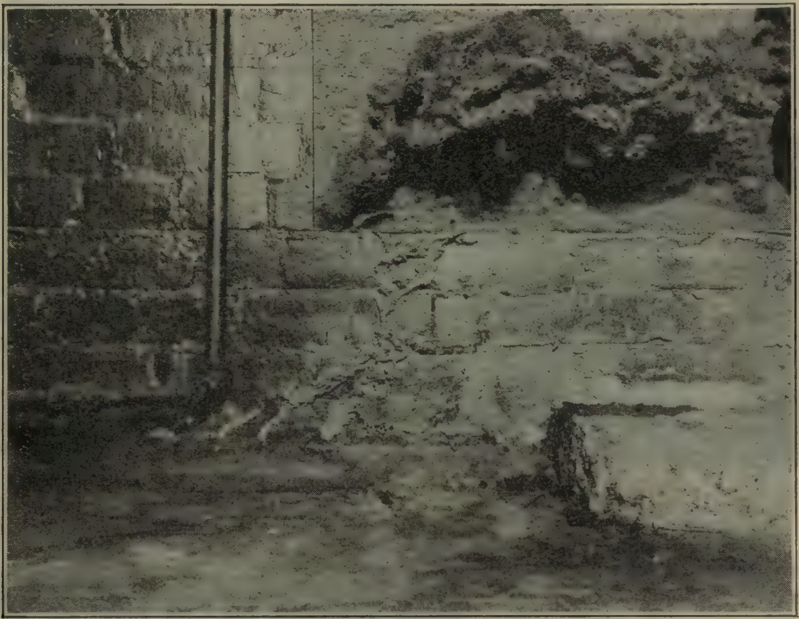

FIG. 11.—Carton, earthlike, shelter tubes constructed by the eastern subterranean termite *Reticulitermes flavipes* over brick wall in dark, heated, damp basement; these tubes are used in passing over impenetrable substances. Inset, near view of tubes to show texture

It will be seen that this is faulty construction. Termites have free access from the earth, in which they have galleries, through the porous conglomerate, to the untreated beams and flooring. *There should be a layer of solid concrete at least 1 inch thick between the grout and the wood.* (Fig. 17, B.)

Among the commonest means of infestation are wooden sleepers or stringers laid in concrete while the latter is still soft, or placed before the concrete has been poured in. Termites enter through these wooden beams. Other common means of infestation are supports of coal bins extending through concrete and through the disintegrated lime mortar of brick walls.

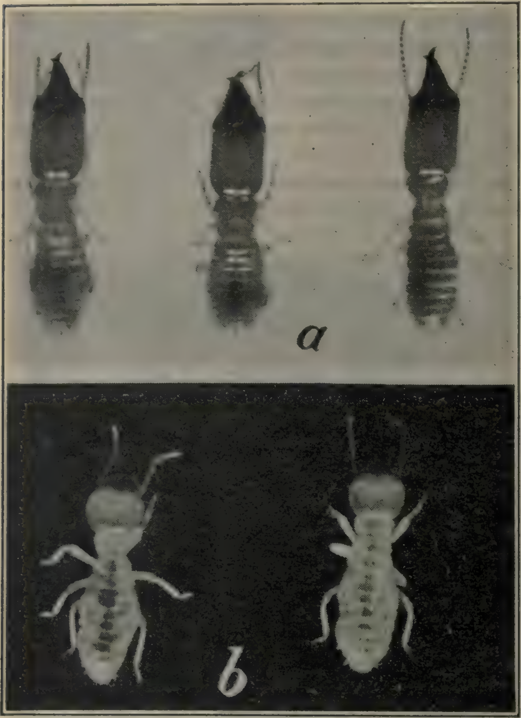

FIG. 12.—Mature soldiers (*a*) and mature workers (*b*) of the eastern subterranean termite *Reticulitermes flavipes*. Slightly more than six times natural size

Termite shields, guards, or metal caps.—The most injurious termites in this country are subterranean in habit and require constant access to the earth in order to attack wood which is either in contact with the earth or which they reach through covered, earthlike shelter tubes constructed over the face of stone, concrete, or brick foundations. In consequence they can be kept out of buildings by means of metal barriers. By simply inserting a sheet of galvanized iron or "termite shield" into the masonry and turning the projecting edges downward at an angle, communication of termites with the earth, where they obtain moisture, can be cut off. In less pretentious frame buildings, metal caps are placed over the tops of construction stone piling or pillars, or wooden supports.

This is a similar method to that used in rat-proofing corn cribs. It is effective and practicable where untreated timber is placed over masonry foundations.

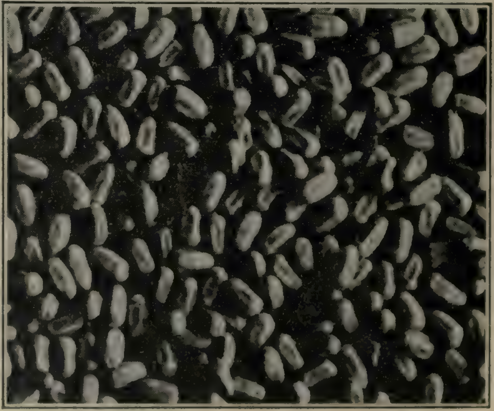

FIG. 13.—Impressed pellets of excrement of nonsubterranean termites (*Kalotermes* sp.), which drop from infested wood. Greatly enlarged

Again, in the case of stone and steel buildings, the steel or stone pillars or piping extending down through the concrete floor to foundations in the earth often make infestation possible, owing to the fact that the concrete floor does not fit tightly about them. Overlapping strips of metal extending horizontally several inches from the pillars or pipes should be imbedded in the concrete floor in order to obtain a tight joint (fig. 17, B); or liquid (adhesive) asphalt should be poured in to plug up the crevice or frame.

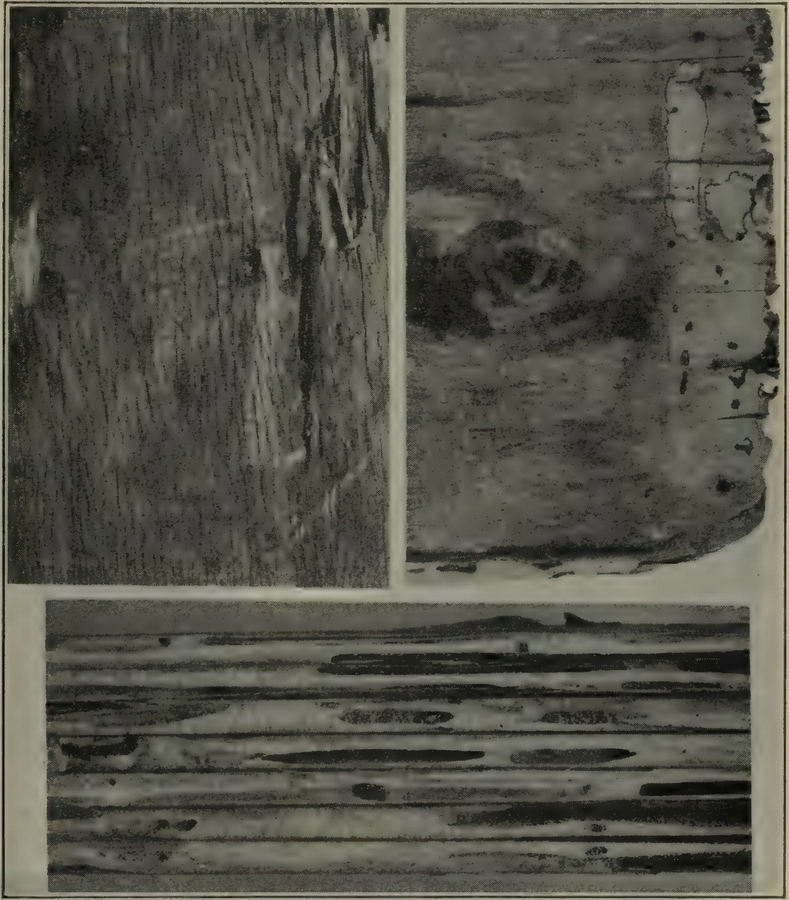

FIG. 14.—Bottom of bureau drawer damaged by the nonsubterranean wood-boring termite *Cryptotermes brevis,* which occurs at Key West, Miami, and Palm Beach, Fla.

Avoiding dampness.—Complete dryness of foundation timbers and basement walls and flooring is an important aid in rendering buildings safe from attack by termites. Dampness, warmth, and darkness attract these insects. A deep air space should be left between the ground and wooden flooring, unless, as in factories, heavy trucking is to be used over the floor, in which case this is impracticable.

An air space should be left between the concrete floor and the wooden floor laid over it. Concrete floors should be laid on a gravel base, which will prevent dampness and cracking. The points of juncture between concrete walls and wooden flooring should be filled in by rounding off the concrete at these places, since cracks often occur where the wall and floor join at right angles. (Fig. 17, B.) Termites often come up through cracks between walls and flooring.

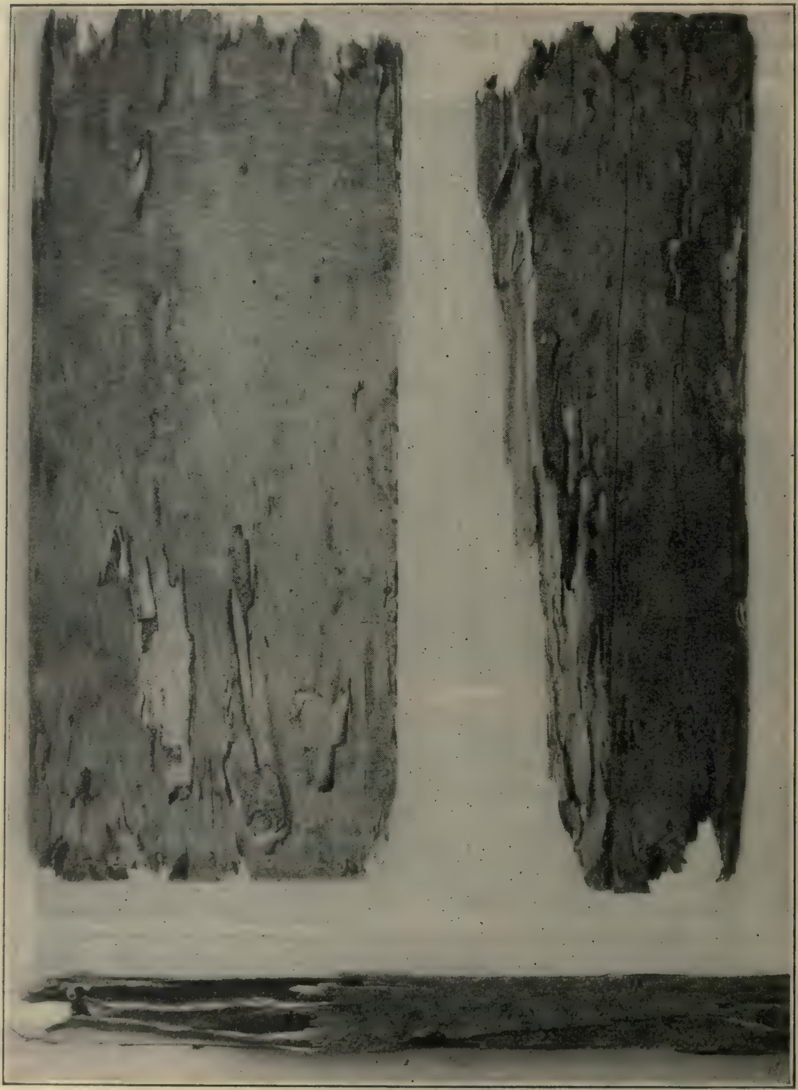

FIG. 15.—Furniture damaged by the nonsubterranean, wood-boring termite *Cryptotermes brevis,* Key West, Fla.

By mixing a heavy mineral residual oil with Portland cement, a material is formed almost perfectly nonabsorbent of water and therefore excellent for use in damp-proof construction. Where the various patent or noiseless floorings are used on the ground floor they should always be laid over a concrete base, especially if they contain wood fiber as a constituent.

In no case should beams be completely surrounded with mortar or brick; there should be a space around them sufficient to permit air circulation. Beams should not be set in earth or in moist concrete, but on rock or dry concrete, or in grooves in the latter.

Bungalows or frame buildings which have no cellar should be raised from the ground on stone, concrete, or brick foundations to a height which will allow light and air to penetrate beneath.

Avoiding lime mortar.—In brick walls, where lime mortar is used, this sometimes disintegrates after a few years and termites penetrate through the spaces thus left between the bricks, especially where the brickwork is below the ground level. (Fig. 16.) Such walls should be faced with Portland cement 1 inch thick, especially if untreated wood is to come in contact with the bricks.

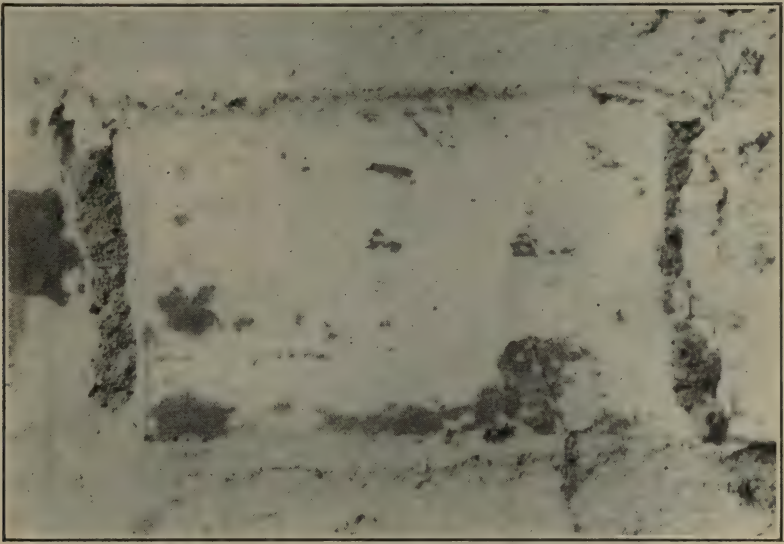

FIG. 16.—Interior view of portion of whitewashed brick foundation wall of building, below ground level, showing shelter tubes of our common subterranean termite (*Reticulitermes* sp.) penetrating the disintegrated lime mortar. These termites came through the earth banked up against the exterior wall. To remedy this condition the exterior wall will have to be faced with concrete for some distance below the ground level

Use of chemically treated wood for interior woodwork, furniture, etc.—In the Southern States, especially in the subtropics, in the more valuable permanent buildings the interior woodwork, furniture, etc., should be impregnated with preservatives, since nonsubterranean termites that attack wood directly are common in those regions. Zinc chloride, bichloride of mercury,[5] sodium fluoride, and chlorinated naphthalene[6] are effective preservatives.

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[5] The extremely poisonous character of mercuric chloride renders its use dangerous. It is slowly volatile, and there is a possibility that it will be given off continuously in small quantities from the treated wood. However, it has been extensively used in Germany and apparently without serious consequences.

[6] This preservative is usually referred to as trichlornaphthalene and, as compared with other chemicals, it is really comparable to a technical product having naphthalene, monochloronaphthalene, dichlornaphthalene, and probably some of the higher chlorinations as impurities. Its melting point ranges between 190 and 210° F.—the specification under which it is sold.

Wood-pulp products, such as the various wood-fiber processed or composition boards, or cane-fiber boards, for interior finish and substitutes for lath (fig. 18), or for exterior use, can be protected from attack by termites by adding certain poisons, such as crude carbolic acid, to the pulp or laminated boards in the course of manufacture. Available poisons for this purpose are crude carbolic acid at the rate of 1 gallon to 1,000 square feet; bichloride of mercury at the rate of 49 ounces per 1,000 square feet; or copper sulphate at the rate of 113 ounces per 1,000 square feet.

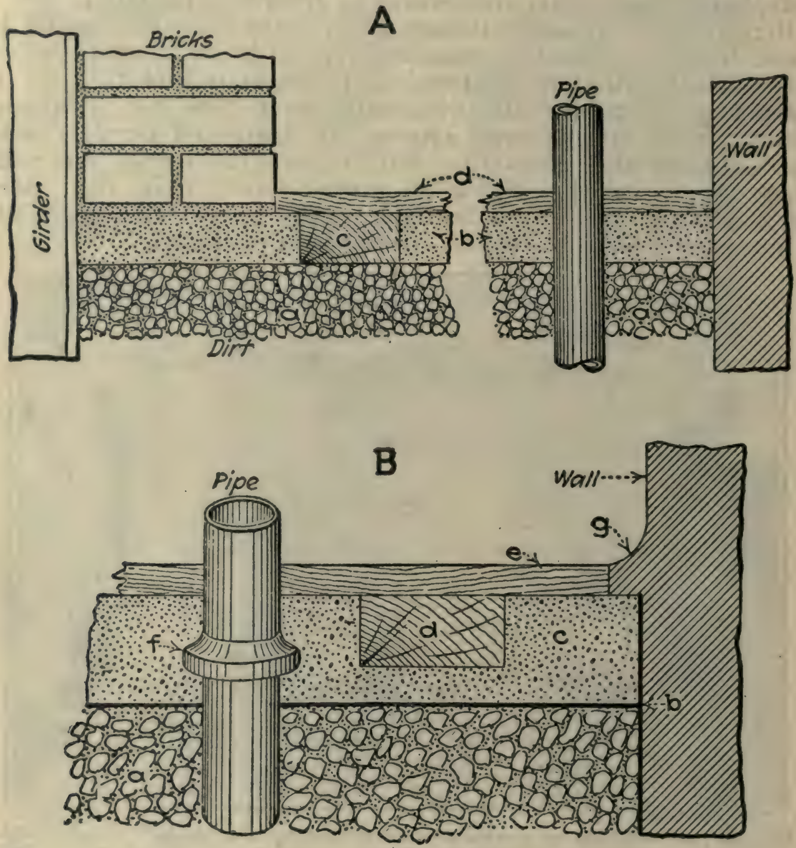

FIG. 17.—A, Improperly constructed concrete flooring: *a*, Gravel or cinders loosely cemented with coarse concrete, 3 inches thick, but with many crevices and holes; *b*, solid, dense concrete, 2 inches thick; *c*, 2 by 4 inch untreated wood sleeper set in moist concrete over the grout; *d*, ⅞-inch pine flooring nailed to sleepers. B, Properly constructed concrete flooring: *a*, Gravel or cinders loosely cemented with coarse concrete, but with many crevices and holes; *b*, asphalt waterproofing ⅛ inch thick; *c*, dense concrete, 3 inches thick; *d*, 2 by 4 inch wood sleeper set in a groove in concrete which insulates it from termites in the earth; *e*, ⅞-inch flooring nailed on sleepers; *f*, metal collar around pipe which runs down through the concrete (this collar should be soldered to the pipe and embedded in the concrete); *g*, shoulder of concrete at point of wall and concrete floor to avoid a right-angle connection and consequent cracking

MODIFICATIONS OF CITY BUILDING CODES

One of the simplest and most effective means of prevention of attack would be to modify the building regulations or codes of various cities so as to include a few simple rules to protect houses from damage by termites. As the principal object in view is to keep all untreated wood from contact with the ground, where the termites live and from which they get their moisture, the regulations should stipulate that no floors, sills, beams, clapboard, etc., of untreated wood may be laid on or in the earth, and that untreated beams may not be laid in concrete without at least 1 inch of concrete underneath and separating it from the earth; that no lime mortar may be used in foundations or in cellar walls where they are in contact with the earth, since termites are able to penetrate lime mortar[7] after some years' service; that all brickwork extending below the surface of the ground shall be faced and capped with concrete at least 1 inch thick; and, where nonsubterranean as well as subterranean termites occur, that only woodwork impregnated with preservatives be used for exterior and interior construction, unless it is impracticable to obtain such treated wood.

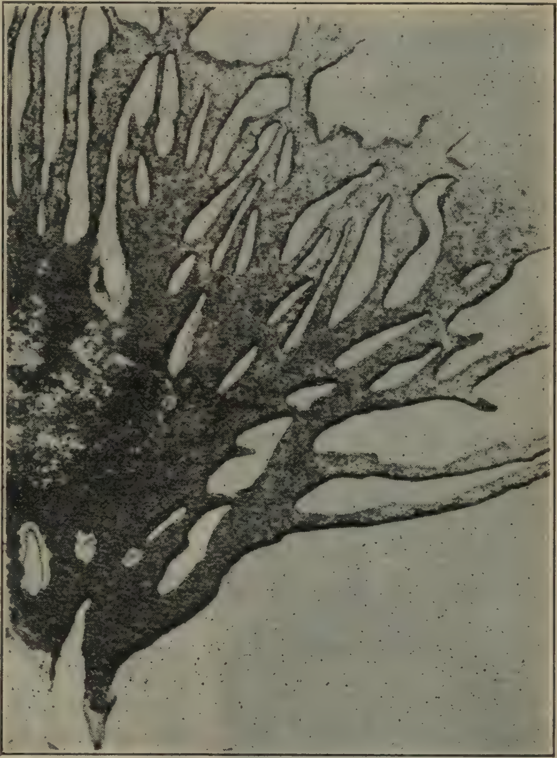

FIG. 18.—Pressed wood-pulp tile mined by subterranean termites infesting the building, Biloxi, Miss.

LOCATING AND TEMPORARILY ARRESTING THE DAMAGE

Although it may be difficult to eliminate termites and stop further damage by them, when once these insects have become established in the woodwork of a building, the approximate point of entrance should be sought at once by careful examination of all woodwork in contact with the ground. To do this, it may be necessary to tear up the foundations, flooring, and some other woodwork. The foundation timbers and interior woodwork found damaged should be removed, and the ground where they were set should be broken up and drenched with some liquid which will kill or at least temporarily prevent the further activity of termites at that point. Any of the insecticides[8] mentioned under the heading "Destruction of breeding places about the building site" (p. 6) will meet the need.

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[7] The Bureau of Standards of the United States Department of Commerce recommends a mortar composed of 1 part Portland cement to 3 parts of sand graded from fine to coarse, with no grains larger than will pass through the No. 10 sieve, to which may be added 10 per cent by weight of the cement of some workability agent, such as hydrated lime, for use in locations where termites abound. Such a mortar, it is believed, will have the desirable properties of both cement and lime mortars and, furthermore, will contain a sufficient quantity of cement to prevent the penetration of it by the termites. (See fig. 16.)

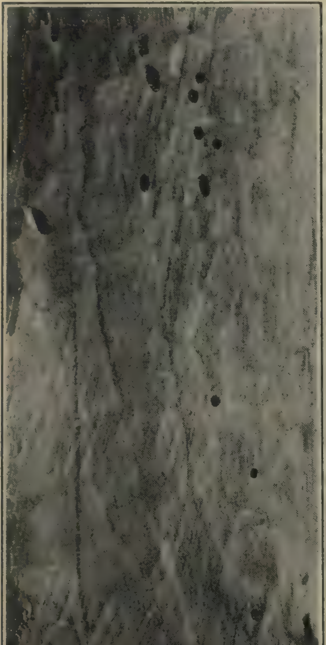

FIG. 19.—Entrance holes of sexual, colonizing adults of a nonsubterranean termite (*Kalotermes hubbardi*) in wood of dead cottonwood tree in Arizona

INDICATIONS OF INFESTATION

The annual emergence of large numbers of the flying termites is an indication as well as a warning that the woodwork is infested, and the point of emergence indicates the approximate location of the infested timbers. Even if the insects are not observed "swarming," large numbers of the dead winged adults or of the discarded wings usually will be found near by. Frass and earth thrown out of crevices through which the insects emerge are also evidences of their presence. Another warning is the presence of branching shelter tubes of small diameter, made of earth mixed with finely powdered wood, on foundation timbers or other woodwork, or over the surface of stone, brick, or other impenetrable foundation material (fig. 11), through which the insects travel from the ground to the woodwork. These tubes should be broken off and the ground where they originate broken up and drenched with one of the liquids named in the paragraph under the heading, "Destruction of breeding places about the building site" (p. 6).

In the case of the nonsubterranean termites, which infest wood directly, evidences that they are damaging wood are the impressed pellets of excrement (fig. 13) which are expelled from the wood. Other evidences are the holes, similar in size to BB shot, where the insects entered the wood. (Fig. 19.)

KILLING THE WINGED ADULTS WILL NOT STOP THE DAMAGE

When efforts are made to prevent further damage by termites in buildings, it should be realized that the numbers of these insects may be constantly recruited from some undiscovered, outside, central colony. The destruction of the winged colonizing adults with household ammonia, etc., at the time of emergence, although beneficial in preventing the establishment of new colonies, will not eradicate the insects infesting the woodwork. The most destructive forms are the white, wingless workers, which remain within the wood.

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[8] If sodium cyanide is used, a strong solution, 1 ounce to a gallon of water, is desirable.

DISCONNECTING WOOD FROM THE GROUND

Subterranean termites infesting beams or other wood will die out if the wood is disconnected from the ground. Knowledge of this fact will save time and expense, especially in the case of old frame buildings, where extensive repairs would be unwarranted. Disconnecting untreated foundation timbers from contact with the soil will also cause the death of subterranean termites in the other woodwork, furniture, and stored material in the building, even if they have penetrated to the second or third floors. These timbers need not be removed or replaced unless seriously weakened structurally. However, if the wood is kept moist by some other means, such as water leakage, the termites will continue to work and thrive. This applies especially to damp corners of basements near outside water pipes, bathrooms, kitchens, and the like.

Wooden floors laid directly on the ground or on stringers on the ground, or set in concrete, should be removed. There should be a layer of concrete between the earth and the wooden floor (fig. 17, B). Wooden baseboards should be removed.

REPLACING WITH CONCRETE

Concrete floors and concrete baseboards should be substituted for wood. Untreated beams penetrating through concrete floors into the earth and the lower parts of door jambs and casings should be cut off at least 6 inches above the ground or floor and replaced with cement plinths, which should project one-quarter inch beyond the jambs and casings. Metal strips should be sunk down from the woodwork into the concrete. Wooden thresholds, wainscoting, window sills, subsills, and stools in the basement or ground floor should be removed and placed on concrete (a layer of concrete between the earth and wood) or replaced with concrete.

REPLACING WITH METAL

In basements and cellars steel rails or other structural metal work can sometimes be economically used to replace weakened timbers.

FUMIGATION AND SPRAYING

Fumigation and spraying are of no permanent value against subterranean termites in buildings, since, while they may kill the flying insects and some of those in the wood, others will continue to come up from the ground.

In the case of termites which do not live in the ground, however, but attack wood directly, fumigation with hydrocyanic-acid gas will kill them in the woodwork of buildings, boats, etc. Infested woodwork should be opened up and exposed as much as possible. Furniture should be stored in a tightly closed room and there fumigated. The woodwork of several boats and large hotels in Florida has been successfully fumigated with hydrocyanic-acid gas according to the recommendations of the Bureau of Entomology.[9] Where the termites had infested several stories of the buildings, the windows were sealed, and after the fumigation was completed the rooms were aired by opening windows with cords from the outside. The usual proportions were employed;[10] that is, 1 ounce (avoirdupois) of sodium cyanide to 1½ fluid ounces of sulphuric acid and 3 fluid ounces of water; but 12 ounces of the cyanide was used per 100 cubic feet of room capacity, instead of the 10 ounces recommended by the Bureau of Entomology, making the gas 20 per cent stronger. This fumigation resulted in the death of the insects within the wood.

In southern Florida, where serious damage is caused to buildings by the West Indian termite *Cryptotermes brevis* Walker, fumigation is recommended just before the winged adults fly (about the middle of June). At that time these insects are in the outer layers of the wood where they are readily accessible, and the fumigation will destroy large numbers of them.

HEAT

Nonsubterranean termites can be killed by the use of heat. In southern Florida these insects were killed in furniture by placing it in an attic with a glass skylight, where the sun's rays caused a very high temperature, from 17 to 24° F. higher than the maximum temperature recorded by the United States Weather Bureau. Temperatures of 110 to 120° F. and over, artificially produced, can likewise be utilized in controlling this class of termites.

INSECTICIDES

Poisons can be used to kill nonsubterranean termites within the wood. Insecticides useful for this purpose are orthodichlorobenzene, or a 10 per cent solution of kerosene emulsion poisoned by dissolving 1 ounce of sodium arsenite in each gallon of water used for diluting stock mixtures of kerosene emulsion or miscible oils. The infested wood is drenched with the chosen insecticide by swabbing with a saturated rag or mop; several treatments may be necessary, and the wood should be placed in quarantine and carefully watched until it is certain that all the termites are dead.

Poisons for subterranean termites are enumerated under the heading " Destruction of breeding places about the building site " (p. 6).

PREVENTING AND REMEDYING INJURY TO LIVING VEGETATION

FRUIT, NUT, SHADE, AND FOREST TREES

Termites cause occasional but serious injury to living trees, shrubs, nursery stock, and grapevines. A wise preventive measure is the removal of all loose wood which may afford them shelter, such as prunings, dead and dying trees and the like, and untreated fence posts and similar material. Cleanliness in orchard and forest management is important. Since termites render unmerchantable the forest trees which have been killed by insects, fire, or disease, all timber from such trees should be utilized or removed as promptly as possible.

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[9] See Farmers' Bulletin 699, Hydrocyanic-Acid Gas Against Household Insects. For detailed instructions for fumigating with hydrocyanic-acid gas this publication should be consulted, or application made to the Bureau of Entomology, United States Department of Agriculture, Washington, D. C.

[10] By the State Plant Board of Florida in cooperation with the Bureau of Entomology, United States Department of Agriculture.

Covering scars and pruned areas.—To prevent infestation, care should be taken that the trees do not become scarred, especially near the base. Scars and all pruned areas should be treated with a mixture of one-fourth creosote and three-fourths coal tar. This mixture should not be allowed to come in contact with the living tissues at the edges of the bark; to protect them a shellac should be applied.

Commercial fertilizers.—Soil heavily manured will attract subterranean termites, since they can obtain food from the animal manure; commercial fertilizers should be used in preference in regions where termites are common in the soil.

YOUNG PLANTATIONS OR NURSERY STOCK

Injury to nursery stock will be more serious on recently cleared land, to stock from 1 to 3 years old, and where decaying wood is abundant. Any débris in which the insects breed should be removed. In general the use of recently cleared land should be avoided in planting nursery stock. Earth used in banking should be free from rotten wood. Care should be taken not to allow the roots to dry out before planting, as weakened stock is specially susceptible to attack; particular care should be given grafted stock. In the case of the pecan it is recommended that two or three cereal crops be grown on newly cleared land before the young trees are set out.

Tree surgery.—Properly executed tree surgery [11] sometimes is effective in repairing injury by termites to valuable old fruit and shade trees.

Insecticides.—When valuable trees are infested but not yet dying, subterranean termites can be killed in the soil, if it is moist and not too compact, by breaking it up near the tree and pouring carbon disulphide on the earth at a distance of about a foot from the trunk, then covering the liquid over with earth. The gas from this liquid will penetrate the subterranean galleries of the termites. It is somewhat dangerous to plant life and very large doses should not be used. *Care should be taken in handling this volatile fluid, as the gas or vapor from it is highly inflammable and explosive when mixed with air in certain proportions; no flame should be brought near it, and the fumes should not be inhaled, as they are poisonous.* There are indications that an emulsion of carbon disulphide, which is on the market ready for use, may prove more effective than carbon disulphide alone; as in the case of the disulphide itself, the earth is loosened up and the emulsion poured on, at least a foot from the tree. Carbon tetrachloride,[12] the gas from which is neither explosive nor inflammable, can be similarly used but is apparently not so effective as carbon disulphide. The gases from carbon disulphide and carbon tetrachloride, being heavier than air, will not readily rise.

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[11] For information on this subject the reader is referred to Farmers' Bulletin 1178, "Tree Surgery," which may be obtained on application to the United States Department of Agriculture.

[12] Carbon tetrachloride is a thin, transparent, colorless, volatile liquid, which forms a gas with a pungent, aromatic odor. Like carbon disulphide it is heavier than air. Although it is only about one-half or one-third as effective as carbon disulphide when used at the same dosage rate, it has the great advantage that its gas is neither explosive nor inflammable; there will be no fire risk attending its use in buildings.

If tree trunks or branches are infested, they must be treated with poisonous liquids, such as kerosene emulsion poisoned with sodium arsenite.[13] Orthodichlorobenzene is probably useful in the same way. When treating the infested portions, which are usually in the dead heartwood, these liquids must not be permitted to come in contact with living plant tissue.

VINEYARDS

In vineyards all dead or diseased vines should be removed. All exposed areas left by pruning should be painted with preservative coatings and the prunings should be burned promptly. Near-by stands of tree windbreaks should be carefully cared for and kept free from infestation by termites. Trellis posts should be creosoted.

FIELD AND TRUCK CROPS

Deep fall plowing.—Deep, late, fall plowing will be of value in breaking up the galleries and nests of subterranean termites on ground planted to field or truck crops. Irrigation of the land, where practicable, will be effective; this can be done before planting the crop.

Burning stubble.—Care should be taken not to plow under stubble which will serve as food for termites; it should be burned. The use of commercial fertilizers instead of animal manure is also recommended where subterranean termites are common in the soil.

Insecticides.—Injury to corn in the prairie region of Kansas has resulted from the presence of termites in enormous numbers in the heavily sodded soil, where they feed on the roots of the vegetation. Such soil should be plowed up and treated with insecticides before crops are planted; effective insecticides are sodium arsenite and sodium cyanide. (See p. 6.)

Rotation of crops.—As a result of the frequent stirring of the soil, rotation of crops will aid in preventing termites from injuring them.

FLOWERS AND GREENHOUSE STOCK

Termites injure a great variety of flowers in gardens, as well as many plants grown under glass in greenhouses, where the warm, moist atmosphere maintained throughout the year promotes greatly the activity of the insects. Injury from termites is especially common where the plants are perennial and have woody stalks.

Sources of infestation.—Heavily manured flower beds are a source of infestation to the stems of the flowers, as well as to the woodwork of buildings near by, if suitable protection is lacking. Untreated wooden stakes used as supports of plants often become infested, and in time the insects attack the plants. In greenhouses termites often attack old label sticks, the wooden uprights supporting wooden benches set on or in the ground, and the wooden bench bottoms and plant pots, and later attack the growing plants. The insects come up through the ground and form dirt galleries over the supports, or burrow up through the wooden bench legs and run galleries the full length of the benches. They enter the soil in the pots through the drainage holes and eat out the main stalk of the root, killing the plant very quickly.

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[13] In each gallon of the water used for diluting kerosene emulsion or miscible oil, dissolve 1 ounce of sodium arsenite.

Proper construction of greenhouses.—Proper construction of greenhouses will practically safeguard plants growing in them from all injury by termites. Iron frames and concrete work should, wherever possible, replace bricks or woodwork. In cases of infestation of old greenhouses all wooden uprights supporting wooden plant benches should be sawed off, if set on or in the ground, and rested on stone, bricks, or concrete, above the surface of the ground. Proper repairing, including the removal of all infested wood, will prevent the plants from becoming infested in turn. Where woodwork is necessary the wood should be impregnated with zinc chloride or bichloride of mercury; it can be painted after treatment. Wood impregnated with coal-tar creosote can not be used with safety in greenhouses.

Avoiding stable manure.—In flower gardens, especially those located near the woodwork of buildings, commercial fertilizers should be substituted for stable manure in order to protect not only the buildings but also the growing plants.

Insecticides.—Either carbon disulphide or carbon tetrachloride[14] can be used to kill termites in the soil if it is moist and not compact. Small holes should be made near the infested plants and a small quantity of the liquid chosen poured in and the holes immediately closed tightly with earth. Calcium cyanide[15] has also been found effective, but it should not be placed near living plants; it mixes readily with and enriches the soil and gives off an insecticidal gas which *should not be inhaled, as it is poisonous.*

An effective control may be found in the use of kerosene nicotine oleate or a 5 per cent kerosene emulsion.[16] If the greenhouse benches are infested, but for any reason can not be replaced, they should be soaked thoroughly with this emulsion, as should also the ashes and sand under the pots on the benches. This may be done by removing the potted plants from a section of the bench, spraying that section, and moving the pots on the bench to cover the treated area, thus giving access to another section. Potted heliotropes and geraniums have been treated directly with the 5 per cent kerosene emulsion without injury to the plants, and the white ants in the soil of the pots were all killed. The soil should be wet down before this spray is used. This treatment should be given late in the afternoon and be followed early the next morning with a thorough syringing of the soil with water to wash out the surplus oil. It is important to remove all infested pots from the bench as soon as the infestation is noticed and to destroy the termites with kerosene emulsion.

SUMMARY

Damage by termites or "white ants" is serious to many classes of crude and finished forest products and is occasionally serious to living trees and other plants. These insects are especially injurious to foundation timbers, the woodwork of buildings, and material stored in buildings to which they have gained entrance. Damage to timber in contact with the ground is especially serious in the Southern, Central, and Pacific Coast States and the tropical possessions of the United States.

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[14] See footnote 12 (p. 19).

[15] Two ounces of calcium cyanide to 1 square yard of ground is recommended.

[16] Kerosene emulsion is made as follows: Kerosene, 2 gallons; fish-oil soap, one-half pound; water, 1 gallon. Dissolve the soap in hot water and pour in the oil slowly, with constant stirring to emulsify.

Dilution: If 37 gallons of water be added to the above stock emulsion it will give 40 gallons of 5 per cent kerosene emulsion.

The woodwork of buildings can be protected from the attack of termites by proper construction and by the use of wood treated with preservatives. These insects can be eliminated where already established in buildings by removing wood in contact with the ground and replacing it with wood chemically treated.

To construct buildings so that they will be white-ant proof, make their foundations, where possible, entirely of stone, brick, or concrete, including stone or metal columns or pillars in the basement to support the floor above; make concrete walls and flooring in basement or cellar, and lay concrete floors on a gravel base. Where stone or concrete foundations are impracticable, use timber impregnated with coal-tar creosote.

Lay basement-window sills and frames over concrete, and do not allow woodwork to come in contact with the ground. Never sink untreated timber in the ground or in moist concrete.

Complete dryness of the foundation and of the basement walls and flooring is an important means of rendering buildings safe from attack. Provide for air spaces between the ground and wooden flooring and lay concrete floors on a gravel base.

In regions where nonsubterranean termites are common (see map, fig. 1) woodwork should be treated with preservatives.

To eliminate termites already established in buildings, examine the foundation timbers and other woodwork in the basement to determine the approximate point of entrance and the extent of damage already accomplished. After removing the damaged wood, drench the ground with insecticides or poisonous solutions. Then replace the damaged timber with rock, brick, concrete, or metal work, or substitute, for the foundation, timbers impregnated with coal-tar creosote.

Since subterranean termites always require access to damp earth, shut off this source of moisture. The insects will then be unable to extend their galleries farther and will perish.

Nonsubterranean termites can be killed in infested wood by fumigation with hydrocyanic-acid gas, by exposure to a temperature above 110° F., or by the use of insecticide solutions.

Injury to living vegetation is occasionally serious, especially in the Southern States, the Southwest, and the Pacific Coast States. It can be prevented by clean cultural methods, deep fall plowing, and the use of insecticides.

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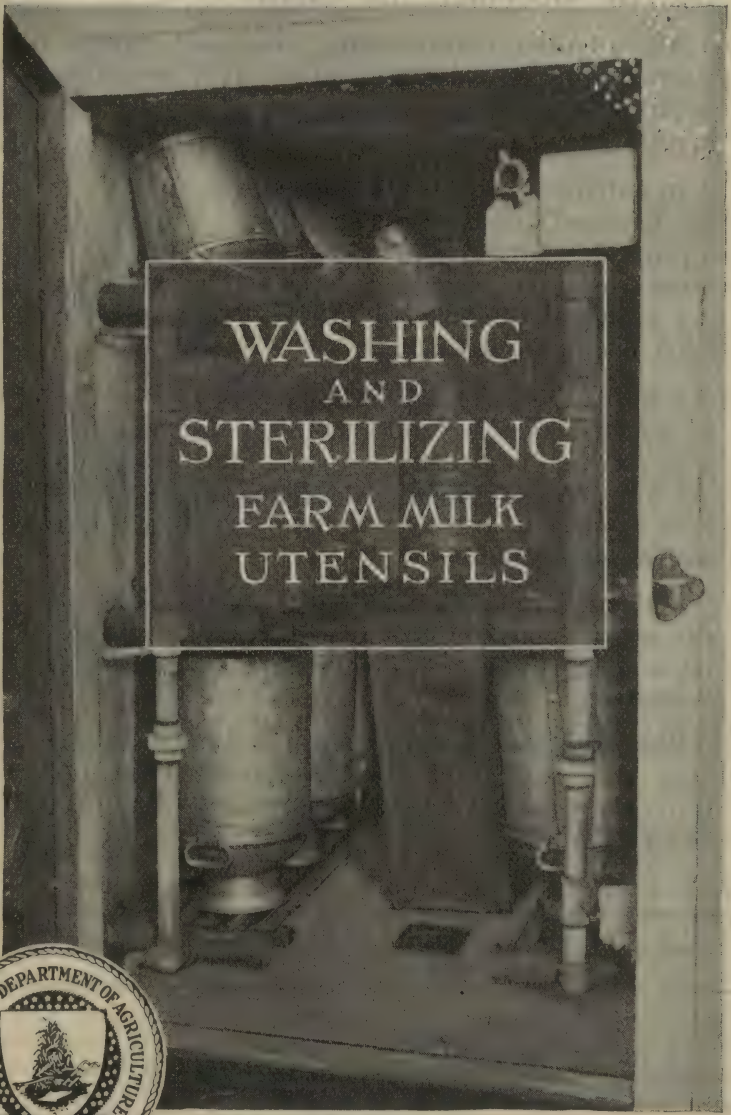
FARMERS' BULLETIN No. 1473



WASHING AND STERILIZING FARM MILK UTENSILS

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ALL UTENSIL SURFACES with which milk comes in contact should be sterilized before being used. The word "sterilized," as used in this bulletin, means to destroy practically all bacteria, including those which may cause disease.

All utensils, before being steamed, should be washed with warm water and an alkali or soda-ash washing powder and rinsed in clean, pure water; brushes, not rags, should be used.

In dairies which have steam boilers, utensils may be sterilized simply and effectively by being put into a properly constructed cabinet, after which steam is turned in. Perforated coils on the floor of the cabinet distribute the steam evenly and increase the efficiency of the sterilizer.

A galvanized-iron box sterilizer and water heater in which steam is generated by a fire underneath will serve satisfactorily for some dairies which do not have steam boilers. Sterilizers of this type are easy to operate and may be made at relatively low cost by any good tinsmith.

A steam jet may be used for sterilizing such utensils as cans and pails; but in using it care must be taken to steam the utensils until they are thoroughly heated.

Blue prints of different types of steam sterilizers may be procured by writing to the Bureau of Dairying, United States Department of Agriculture, Washington, D. C.

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WASHING AND STERILIZING FARM MILK UTENSILS

By R. J. Posson, *Assistant Market Milk Specialist, Bureau of Dairying*

ONE OF THE GREATEST sources of sour milk and low-grade dairy products is the unsterilized utensil. The tiny bacteria that cause souring, off flavors, and sometimes sickness, grow very fast on the moist surfaces of unsterilized pails, strainers, cans, etc. Although utensils may have been well washed and appear clean to the eye, they are not really clean unless they have been sterilized. Even in grandmother's day the clean dairy, with its spotless, shining milk utensils which had been thoroughly scalded, was noted for its good butter. And to-day the dairies with clean, sterilized utensils usually lead in low bacteria counts and in products for which there is a special demand.

The quantity and kind of equipment required for washing and sterilizing dairy utensils naturally vary with the size of the dairy. Small dairies many times need only simple equipment; in the larger dairies the utensils usually are washed and sterilized most economically by the use of more elaborate equipment.

THE WATER SUPPLY

For washing and rinsing utensils a clean, safe water supply is absolutely necessary. Contaminated water may be a source of danger not only to those on the farm but to all those who use milk from the farm. Wells and springs should always be protected from surface drainage. The drainage from privies, hog pens, barnyards, and other sources of contamination should always be away from the well, and both springs and wells should be walled in, curbed, and tightly covered.

HOW TO WASH UTENSILS

Milk utensils should always be thoroughly washed and rinsed before being placed in the sterilizer. If this is not done, sterilization is not only made more difficult but milk which may be adhering to the utensils is "cooked on." This makes them harder to clean the next time they are washed and furnishes food for the few bacteria which may remain after the sterilization process, enabling them to multiply and at least partially to defeat the purpose of sterilization.

The same principles apply to washing utensils in dairies of all sizes. Care should always be taken to remove with cold or lukewarm water as much as possible of the foreign material or milk or cream adhering to the surfaces of cans, pails, bottles, and other utensils before placing them in the hot wash water. Otherwise this water will soon become dirty, highly contaminated with bacteria, and unfit for use. By first rinsing the utensils washing is made easier and more effective, and less washing powder is required to clean them. All remaining foreign matter should then be removed by scrubbing with warm water and an alkali or soda-ash washing powder, after which the utensils, before being sterilized. should be rinsed in water which is known to be clean and pure. The wash water should be about as warm as the hands will bear, and it is well to have the rinse water at least slightly warm. The amount of washing powder which is necessary to use in the wash water will vary with the hardness of the water. Enough should be used to "break" the water, so that grease may be removed from utensils. Soap or greasy powder should not be used for washing milk utensils.

EQUIPMENT FOR WASHING UTENSILS

The equipment required for washing utensils in farm dairies of varying sizes where the washing is done by hand is similar in type and simple in construction. In dairies where there are few utensils to wash, smaller wash sinks of perhaps lighter construction than in the larger dairies may be used, and less expensive equipment for heating water will be needed, but in general their needs are much the same.

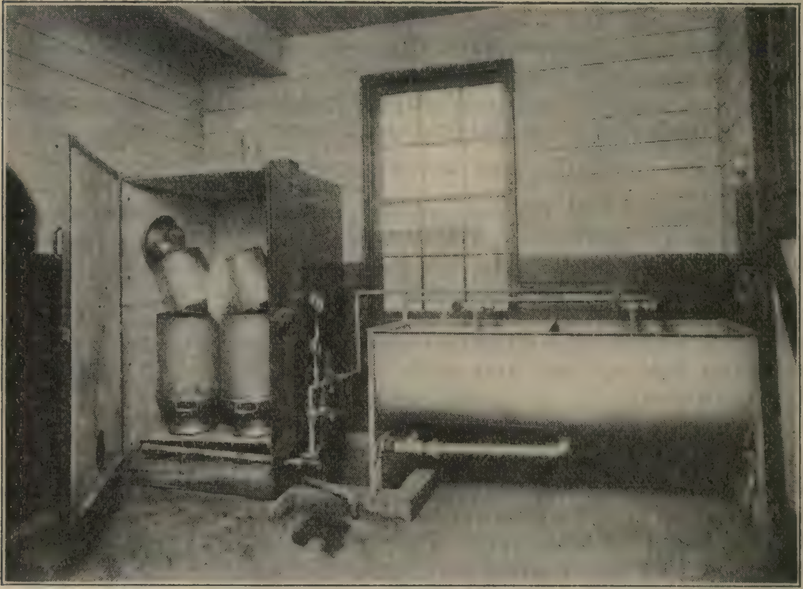

FIG. 1.—A wooden sterilizing cabinet lined with galvanized iron; and a galvanized-iron wash sink, divided into two compartments for washing and rinsing utensils

A galvanized-iron round-bottom sink or vat is a decided help in washing utensils. Such a sink may be purchased at a reasonable cost from dairy supply houses. It should have two compartments, for use in washing and rinsing. By connecting it with a drain and piping running water to it, labor is saved and the work of washing utensils is made much easier. (Fig. 1.)

In the smaller dairies hand brushes aid materially in cleaning the utensils; in the larger ones mechanical brushes may be used to advantage. Hand brushes of varying shapes and sizes for different purposes not only save time but help in thoroughly cleaning the utensils. Rags should not be used, because they are difficult to clean and sterilize and also have a tendency to smear grease and other foreign matter instead of loosening it as a brush does.

A separate room, preferably adjoining the one in which the milk is handled, should be provided for washing utensils. If there are only two rooms in the milk house it is preferable to wash the utensils in the room in which the boiler or stove is situated rather than in the room where the milk is handled. The floor of the wash room should be water-tight and should slope toward a drain.

STERILIZATION BY STEAM

Utensils in dairies which have steam boilers may be sterilized effectively and simply by being put into a cabinet which is free from cracks, after which steam is turned in. If the boiler is of sufficient capacity, the inside temperature of the sterilizing cabinet and of the utensils which it contains may be raised in a few minutes approximately to that of boiling water. If the steam is evenly distributed in the cabinet, and it is ascertained from a reliable thermometer placed in the top of it that a temperature of 200° F. or over has been maintained for five minutes or more, it is certain that practical sterilization of the utensils has been obtained. A slightly longer time gives a margin of safety.

Utensils such as cans, pails, and bottles should always be placed in the sterilizing cabinet in an inverted position. If they are allowed to stand right side up, air pockets may prevent the steam from coming in contact with their entire inner surfaces—at least it will take longer to heat them. Furthermore, an upright position does not allow the condensed steam to drain from them. Large sterilizing cabinets may be equipped with slatted shelves or racks upon which the utensils may be placed. This saves space and aids the circulation of the steam. Bottles may be sterilized in their cases; but, if it is desirable to save space, they may be satisfactorily handled on removable shelves or racks containing openings to receive the necks.

Since steam has a tendency to rise, it should be liberated underneath the utensils and, if possible, at the bottom of the sterilizing cabinet. It should also enter the cabinet from several openings in order to assure even distribution. One way which has proved satisfactory is to admit the steam through a perforated pipe coil, which may be laid on the floor of the sterilizer. Another way is to construct shelves of piping connected with the boiler and of which the center pipe in each shelf is perforated every foot or so. The utensils are inverted on these shelves. Coils similar to the ones shown in Figure 2 may be placed on the floor of the sterilizer. It will be noted in this instance that the steam passes through a long closed coil before it reaches the perforated coil. This closed coil may be used as a radiator to furnish heat for drying the utensils after the valve which admits steam to the perforated coil has been closed.

CONSTRUCTION OF STERILIZING CABINETS

Satisfactory sterilizing cabinets may be constructed of various materials. Reinforced concrete and hollow tile, wood, galvanized iron, brick, or stone may be used—in fact, any material which is not easily damaged by steam and of which a tight box can be constructed. In the case of wood it is better to use two thicknesses of boards put on at different angles to prevent warping. A wooden cabinet built of one thickness of boards, with a water-tight lining of galvanized iron, makes a very satisfactory sterilizer. Care should be taken in constructing a sterilizing cabinet that the door fits tightly and that there are no cracks through which steam may escape.

It is advisable to equip the cabinet with a safety valve set to open before any appreciable pressure is sustained. The ordinary sterilizer will stand very little steam pressure. The advantage of an increase in the temperature at even 2 or 3 pounds gauge pressure is more than offset by the danger of springing a leak and thereby impairing the usefulness of the sterilizer. Practical sterilization may be obtained without applying pressure.

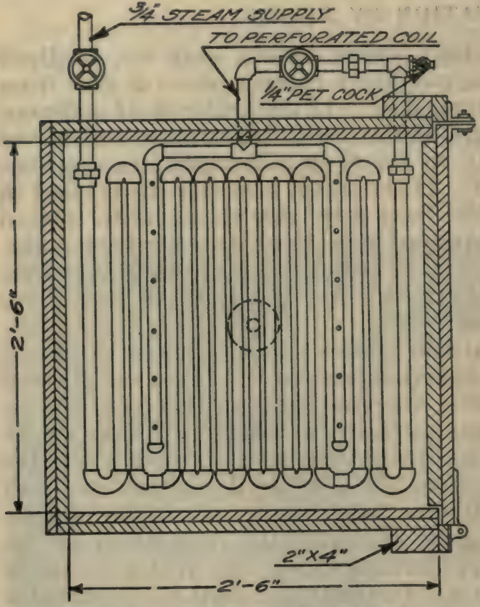

FIG. 2.—Perforated and closed coils which may be used on the floor of the sterilizing cabinet to distribute the steam and dry the utensils after they are steamed. If it is not desired to dry the utensils, the closed coils may be omitted. To dry the utensils, the valve leading to the perforated coil is shut, and the one between the closed coil and the boiler is opened wide

There should be a drain in the floor of the cabinet to carry off condensed moisture. Such a drain should be water-sealed, which may be done by installing a trap in the drain pipe lower than the outlet of this pipe. The lower section of the pipe will remain full of water, which prevents the escape of steam through the drain. If drying coils are to be used after the utensils are steamed, there should be a damper near the bottom of the sterilizer and one in the top. The upper one should open into a galvanized pipe which is extended to carry the vapor outside the building. In constructing a cabinet a small hole in which a thermometer may be fitted should always be provided. The most protected place for this is usually in the top of the sterilizer.

OPERATION OF STERILIZING CABINETS

The operation of a sterilizing cabinet is a simple matter. The time required to obtain a sterilizing temperature in the cabinet will depend upon several factors, including the size and construction of the sterilizer, the capacity of the boiler, the pressure of steam developed, and the temperature of the surrounding air. After the temperature of the cabinet has been above 200° F. for 5 minutes, the valve leading to the perforated coil may be closed. It may be found in practice that the temperature of the sterilizer will remain high for several minutes after the steam is turned off, but this time will vary in different cases.

If glass bottles are being sterilized, steam should be turned in slowly at first; and after sterilization is completed the cabinet should not be opened until its temperature has fallen considerably.

If this rule is not observed, the bottles are liable to be broken, especially if the surrounding air is cold.

Unless they are dried in the sterilizer or are to be used within a few hours after sterilization, utensils should be removed from the cabinet as soon as they are cool enough to handle and inverted on a rack in a protected place to drain and dry. Drying the utensils after sterilization prolongs their life by preventing rust and retards later bacterial growth. If they are to be used for milk 24 hours or more after sterilization, it is important that they be thoroughly dried soon after they are steamed.

Drying coils in the sterilizer will be found to be a distinct advantage in procuring dry utensils. In case these coils are used, before the drying process is started and after the utensils have been steamed the dampers in the bottom of the door and the top of the cabinet should be opened to allow and aid the escape of the moisture which is evaporated from the utensils.

THE GALVANIZED-IRON BOX STERILIZER

In small dairies where the milk is bottled and in some wholesale dairies which do not have steam boilers utensils may be sterilized efficiently and economically in a galvanized-iron box sterilizer. This sterilizer is simple in construction and easy and economical to operate. It may be made by almost any tinsmith at a reasonable cost. It consists merely of a box with a tightly fitting lid, under which heat is applied. It may be set on a concrete, brick, or stone foundation which serves as a fire box, or on a gas or oil stove, or some other heating device. One-half to three-quarters of an inch of water is used in the box.

The utensils are placed in this sterilizer on a slatted rack 1 or 2 inches off the bottom to hold them out of the water. The lid is then put on and enough heat applied underneath the box to boil the water. This generates steam, which soon raises the temperature in the box approximately to that of the boiling water. The sterilization process is exactly the same as for any other steam-sterilizing cabinet, except that the steam is generated within the box.

The bacteria contained in 10-gallon cans after they were washed and rinsed were practically all killed in the sterilizer shown in Figure 3. Bacterial counts showed that each of these cans contained on the average at least 80,000.000 bacteria before sterilization, as compared with 2,100 after sterilization.

This box sterilizer may also be used as a water heater and is a handy means for procuring hot water for washing utensils. If the process is made continuous, the utensils may be placed in the box and sterilized by burning only a comparatively small quantity of fuel after most of the water has been drawn off.

Blue prints of this box sterilizer and instructions for operating it, and also blue prints of sterilizing cabinets for use with steam boilers, are mailed free upon request by the Bureau of Dairying, United States Department of Agriculture, Washington, D. C.

STERILIZATION OF LARGE EQUIPMENT

Utensils and equipment, such as coolers and bottle fillers, which it may not be practicable to put into the cabinet, may be sterilized by covering tightly and turning in steam or boiling water. If running water is available, it may be heated with steam by means of a mixing tee and run over the cooler, or into the bottler and other equipment, at about boiling temperature. Efficient sterilization may be accomplished in this manner. This method is to be preferred to that of attempting sterilization by shooting steam at the equipment through a hose. The boiling water comes in direct contact with the surface of the utensils, kills bacteria, and also rinses the utensils. On the other hand, steam, which is usually applied through a hose, has lost much of its heat by the time it reaches the bacteria and so serves only as a meager rinse. When water is used, care should be taken that it is boiling hot, and that enough is used to heat the utensils thoroughly. A satisfactory way to sterilize bottlers is to fill them full of boiling water and allow them to stand five or more minutes. Milking-machine rubbers and teat cups also may be easily sterilized with hot water, although slightly different treatment is required than for other utensils. Directions for cleaning milking machines are given in Farmers' Bulletin 1315, which is sent free upon request.

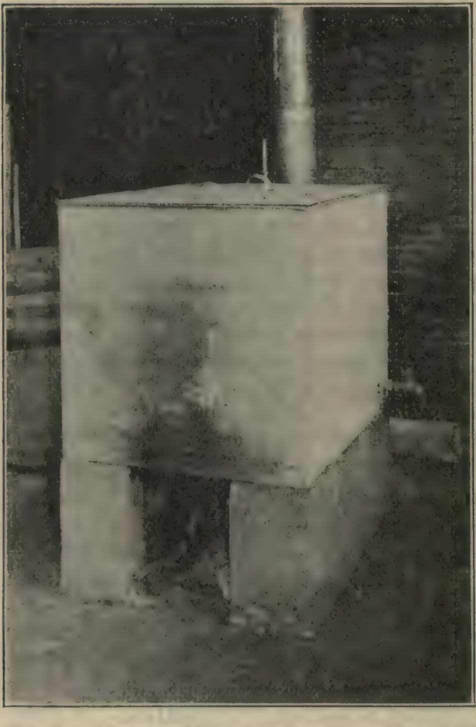

FIG. 3.—Galvanized-iron box steam sterilizer and water heater suitable for small retail and medium-sized wholesale dealers. In the operation of this sterilizer a steam boiler is not required

STERILIZATION WITH A STEAM JET

Utensils such as cans and pails may be sterilized by inverting them over a steam jet, although this system is not to be recommended for general farm use. The effectiveness of the jet will depend upon the steam-gauge pressure used, the size of the opening through which the steam is ejected, and the length of time the utensils are steamed. It usually requires about a half minute to steam a 10-gallon can thoroughly if the steam-gauge pressure is 20 to 25 pounds. If a steam jet is used, the utensils should be steamed until they are too hot to handle with the bare hands. After treatment in this manner they will become dry from their own heat if placed right side up and uncovered for a few minutes before they are inverted on the rack.

Steam jets may easily be made by extending a pipe from the boiler a half inch or an inch through the drain board of the sink and providing a valve directly under it by which the steam may be turned on and off.

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1474

STAIN REMOVAL FROM FABRICS

HOME METHODS

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This bulletin is a revision of and supersedes Farmers' Bulletin 861, entitled "Removal of Stains from Clothing and Other Textiles."

Washington, D. C. Issued August, 1926

STAIN REMOVAL FROM FABRICS: HOME METHODS

Prepared by the Division of Textiles and Clothing, Bureau of Home Economics[1]

GENERAL PRINCIPLES OF STAIN REMOVAL

THE REMOVAL of stains is a necessary feature of the general care of clothing and household textiles. Most stains may be removed easily at home, if reliable methods are known and a few simple precautions taken. Prompt treatment is one of the most important rules. Changes in the character of the stain, brought about by drying, exposure to air, washing, ironing, or in other ways, often make it necessary to use stronger chemicals in removing old stains. However, miracles should not be expected as the result of amateur or even professional efforts at stain removal. Very often the staining substance has so attacked the fabric that it can not be removed without destroying the fibers.

NATURE OF THE STAIN

The nature of the stain should be known, if possible, before its removal is attempted, because this determines the treatment. If an unsuitable remover is used, the stain may be " set " so that its removal becomes difficult or even impossible. For example, if boiling water, which easily removes most fresh fruit stains, is applied to stains containing protein, such as those from milk, blood, eggs, or meat juice, it coagulates the albumin and makes it extremely difficult to remove.

KIND OF FABRIC

The kind of fabric upon which the stain occurs should also be known and the method of treatment chosen which will affect that particular fabric the least. In removing stains from fabrics made from two or more kinds of fibers, such as silk and cotton mixtures, the effect of the stain removers upon all of the fibers should be considered. No chemical should be used which would injure the most delicate of the fibers.

COTTON AND LINEN

Strong acids destroy cotton and linen and even weak ones attack these fabrics to some extent. Therefore, concentrated acids never should be used in removing stains from these fibers. When dilute acids are employed, they should be neutralized afterward with a weak alkali, such as ammonia water, and removed by thorough rinsing; otherwise the acid may become concentrated upon drying and destroy the fibers. Generally speaking, alkalis do not attack cotton or linen fabrics to the extent that acids do. However, long-continued or repeated exposure to alkalis, especially in hot solution, weakens them. All bleaching agents are also somewhat harmful to these fibers and should be used with care and never in concentrated form or for extended periods of time.

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[1] Most of the experimental work on which this bulletin is based was done by Harold L. Lang and Anna H. Whittelsey of the former Office of Home Economics.

WOOL AND SILK

Strong alkalis dissolve both wool and silk and even washing soda or strongly alkaline soap often seriously injures these fibers. The only alkalis that should be used in laundering or removing stains from wool and silk are the milder ones like borax or dilute solutions of ammonia. Dilute acids, with the exception of nitric, which weakens and turns the fibers yellow, do not attack wool and silk readily. Bleaching agents containing chlorine, such as ordinary bleaching powder, are very destructive to both wool and silk and should not be employed.

The use of very hot water on these fibers must be avoided, since it turns both wool and silk yellow, shrinks wool, and injures the finish of silk. Excessive rubbing felts wool, causing it to shrink and thicken, while silk fabrics are likely to be torn. The removal of stains from silk should be done with great care as the mineral salts that are often used to weight such fabrics tend to weaken them.

ARTIFICIAL SILK

Since artificial silk, now commonly called rayon by the trade, is manufactured by a number of different processes, the fibers encountered may vary somewhat. Most rayon is weaker when wet than when dry, and in some cases the strength is so impaired that these fabrics should be handled very carefully while in that condition. Boiling is likely to decrease their luster. Dilute acids are not usually harmful to them, but concentrated acids should not be used. If the artificial silk is composed of cellulose acetate, it will be dissolved immediately by concentrated acetic acid. Acetone, an organic solvent which is valuable for removing many stains, will also dissolve cellulose acetate silk. Since there is a great deal of this type of artificial silk manufactured, it is well to test a sample with these liquids before using them for stain removal. Alkaline solutions rapidly destroy artificial silk, and bleaching agents are often harmful and should be used with great care.

COLORED FABRICS

Bleaches and other chemicals strong enough to remove stains will usually attack dyestuffs. It is therefore necessary to handle colored fabrics more carefully than white ones. They should be treated rapidly and rinsed thoroughly. If the color changes shade when treated with an acid the original color can often be restored by a weak alkali, such as ammonia solution or ammonia fumes. Acetic acid will often restore a color that has been changed by alkalis.

SUBSTANCES USED FOR STAIN REMOVAL

Almost all of the materials used for stain removal may be classified as absorbents, solvents, or bleaches, although there are a few miscellaneous ones whose action is different. Sodium thiosulphate ("hypo"), which forms colorless water-soluble compounds with iodine, and corrosive sublimate, which will act similarly with certain medicinal stains, are examples. These are discussed under the treatment of individual stains.

ABSORBENTS

Such substances as chalk, magnesium carbonate, fuller's earth, and corn meal are known as absorbents. When spread on stained fabrics, these often absorb the staining material. They can then be brushed off readily. Such materials are effective if the stain is light or freshly made, but they can not be relied upon when it is set or very extensive. They are harmless to all fibers.

To use the absorbent powders, lay the stained fabric upon a flat surface and spread a layer of the absorbent over the stain. Work it around gently so as not to pull the fibers. As soon as it becomes gummy, shake or brush it off, and repeat the process until the bulk of the stain is removed. Then apply another layer of the absorbent and allow it to remain overnight, or longer if necessary. This removes all traces of the stain, and in the case of slight stains the preliminary treatment is unnecessary. Then dust or brush off the absorbent thoroughly. If it is not convenient to let the stain stand overnight, place a layer of cloth or brown paper over the absorbent and apply a warm (not hot) iron for several minutes. In the case of stains made by solid fats, which must be melted before they can be absorbed, the use of the warm iron is necessary.

STAIN SOLVENTS

Water and such liquids as ether, wood or denatured alcohol, benzol, acetone, gasoline, chloroform, and carbon tetrachloride are common stain solvents. A large number of stains can be removed by water without harm to the fabric. Unless the stain is known to be insoluble in water and the fabric water spots or the colors run, it is best to try water first. Test by placing a little water on an inconspicuous part of the garment if there seems to be danger of injuring it.

The other solvents mentioned are particularly good for removing stains of a fatty or greasy nature. As the vapors from all organic solvents are injurious when inhaled in large quantities, they should be used out of doors or in a very well ventilated room.

Gasoline, naphtha, and ether are very inflammable and may be the cause of serious fires. For this reason it is not recommended that these be used in the home in quantities large enough to immerse an entire garment. Not only will gasoline take fire easily and often burn with serious explosions, but in dry atmospheres a garment saturated with gasoline will sometimes burst into flames owing to the static discharge caused by rubbing one part of it against another. If small quantities of either gasoline or ether are used for removing spots, they should be plainly marked "inflammable," kept away from flames, and preferably used out of doors. Benzol and acetone are also inflammable. Some of the noninflammable grease spot removers sold under trade names consist entirely or in large part of carbon tetrachloride. All of the solvents mentioned above are harmless to all fibers, but water of course injures many fabric finishes and dyed materials.

BLEACHES

It is often necessary to bleach out a stain, but chemicals should be used carefully. Almost all of them will remove the color of the fabric as well as the stain and, if used in too concentrated a form or allowed to remain on the fabric too long, will weaken it. A number of the more common bleaches are given below. Reference to their use will be found under "Methods of Treating Individual Stains."

JAVELLE WATER

Javelle water may be used successfully in removing a number of stains, but should be applied only to uncolored cotton or linen materials, since it bleaches colors and rots silk, wool, and some kinds of rayon.

The solution usually called Javelle water (more correctly termed Labarraque solution) is prepared as follows: Dissolve one-half pound of washing soda in 1 quart of cold water. To this solution add one-fourth pound of ordinary bleaching powder (commonly called chloride of lime). Filter this liquid through a piece of muslin to remove the sediment which remains. Keep the clear liquid in tightly stoppered bottles.

In treating stains with Javelle water, stretch the stained portion over a bowl filled with water and apply the Javelle water to the stain with a medicine dropper. Do not allow the Javelle water to remain in contact with the fabric for more than one minute. If necessary, the entire garment may be placed in the liquid. Then apply a solution containing one-fourth ounce of sodium thiosulphate and one-eighth ounce of 36-per-cent acetic acid in 2 quarts of water. Sodium thiosulphate ("hypo") is found in many homes where amateur photography is being done and is very effective in removing the chlorine which remains in the fabric after treatment with Javelle water. Rinse thoroughly. Oxalic-acid solution may be used instead of the thiosulphate but is not so satisfactory.

If allowed to remain too long in contact with the fibers, Javelle water rots even linen and cotton materials. It should therefore always be followed very promptly by a solution of thiosulphate and the fabric rinsed thoroughly to remove all traces of the chemical. With persistent stains Javelle water and thiosulphate to neutralize it, may need to be applied several times. Commercial ink removers are similar in action to Javelle water and are very convenient for removing many stains besides ink spots.

POTASSIUM PERMANGANATE

Potassium permanganate can be used in removing certain stains from all white fabrics except rayon. One or more repetitions of the treatment may be necessary in the case of persistent stains. Potassium permanganate may also be used successfully upon many colored materials but should always be tried first on an unexposed portion of the goods in order to determine its effect on the dye. As it may harm delicate fibers, it should be used with great care. Prepare and use the permanganate as follows: Dissolve 1 teaspoon of the crystals in 1 pint of water and apply a little of this to the stain with a medicine dropper, a glass rod, or a clean cork, and allow it to remain for about five minutes. Remove any pink or brown stain left by the permanganate by applying one of the following chemicals:

Hydrogen peroxide, made very slightly acid (if not already so) with hydrochloric, acetic, oxalic, or tartaric acid. This treatment is suitable for wool. Follow by thorough rinsing.

Oxalic acid (poison) in saturated solution or lemon juice for cotton, linen, or silk. Follow by thorough rinsing.

HYDROGEN PEROXIDE

Hydrogen peroxide, as obtained for medical purposes, has usually been made slightly acid, to give it better keeping quality. For use in removing stains make a small quantity of the peroxide slightly alkaline with ammonia solution. Since hydrogen peroxide affects the fiber also, in the case of cotton and linen materials, follow it by very careful rinsing. Apply it to the stain with a medicine dropper, a glass rod, or a clean cork, or sponge the stain with it (see p. 6). The method of using it in connection with potassium permanganate is described above.

OXALIC ACID

Oxalic acid is poisonous and should be used carefully. The bottle in which it is stored must be marked "Poison" and kept out of the reach of children. To prepare a solution, dissolve as many of the crystals of the acid as possible in a pint of lukewarm water. Put into a bottle, stopper tightly, and use as needed. Apply this solution to the stain with a medicine dropper or glass rod and after allowing it to remain for a few minutes, rinse thoroughly in clean water (see p. 6). Neutralize with a solution of ammonia.

HYDROSULPHITES

Hydrosulphites are perhaps the most generally useful bleaching agents for stain removal, sodium hydrosulphite usually being employed. Stable forms are available under many trade names. They should be kept dry in tightly closed cans and not moistened until ready to use. The powder may then be moistened and worked directly onto the stain with the fingers, or it may be dissolved in water and the fabric wholly or partially immersed in the warm solution. These compounds are particularly useful in removing dye which has stained the fabric and are effective on almost all stains which are not greasy in nature. They can not be used on colored material unless the treatment is very rapid and the fabric well rinsed as soon as the stain is removed. Even under such conditions, the color of the fabric is often removed with the stain.

GENERAL METHODS OF TREATING STAINS

SPONGING WITH WATER OR OTHER SOLVENT

If the nature of the stain is not known and it does not appear to be greasy, sponging with a wet cloth may be effective. However, it is always well to try the action of water on some inconspicuous part of the garment unless it is definitely known that the fabric will not water spot or the color be affected.

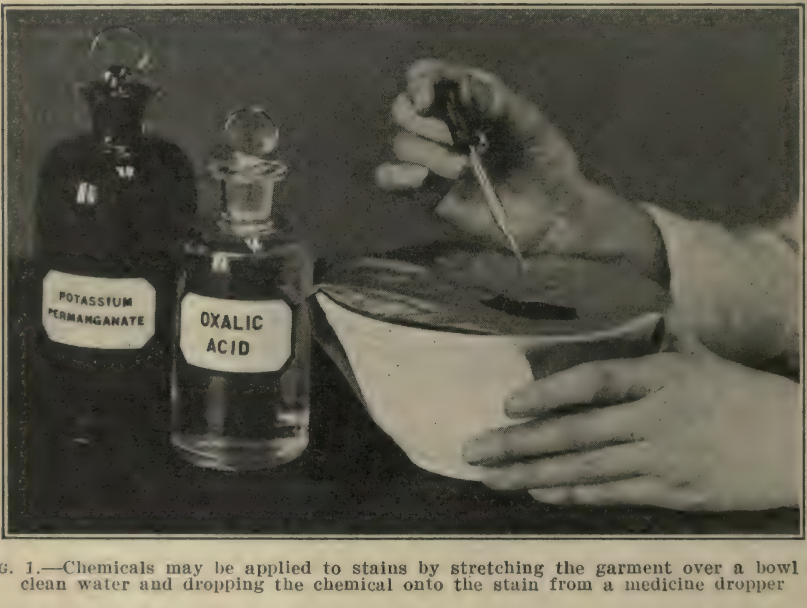

FIG. 1.—Chemicals may be applied to stains by stretching the garment over a bowl of clean water and dropping the chemical onto the stain from a medicine dropper

Spread the article on a flat surface in a good light. Lay the stained material with the wrong side up and apply the liquid to the back, so that the foreign substances can be washed from the fibers without having to pass through the material. A cloth folded several times to form a pad or, better, a clean piece of blotting paper may be placed under the stain to absorb the superfluous liquid. Change the pad or paper occasionally as it becomes soiled. Sponge with a clean, soft, lintless cloth which has been dipped in the liquid and wrung until partially dry. Do not have the cloth excessively wet. Use light brushing motions, spreading the moisture irregularly into the surrounding fabric in order to prevent rings.

APPLICATION OF CHEMICALS

Chemicals should not be used until after water has been tried, unless it is definitely known that water will not remove the stain or that the fabric is unsuitable for water treatment. There is always danger that chemicals will attack the fiber.

However, there are a few common chemicals which are necessary to remove some stains, and these should be kept in every household. As some are poisonous, they should not be kept in the family medicine cabinet or the pantry. Chemicals most commonly used in removing stains are Javelle water, potassium permanganate, oxalic acid, ammonia water, and carbon tetrachloride. The utensils needed are a medium-sized bowl, a medicine dropper, a glass rod with rounded ends, several pads of cheesecloth or old muslin, a small sponge, and sheets of white blotting paper.

If the effect of the stain remover upon the fiber or color is not known, try it by applying a little to a sample or to an unexposed portion of the goods.

Work rapidly when using chemicals to remove stains, so as to give them as little time as possible to act on the textile fibers. Many brief applications of the chemicals, with rinsing or neutralizing after each application, are preferable to allowing them to remain on the stain for a long time.

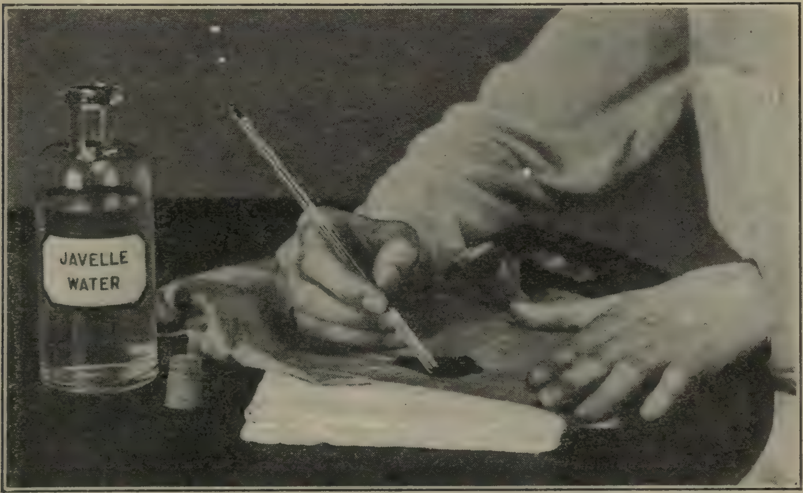

FIG. 2.—A glass rod with rounded ends is convenient for applying chemicals to stains. A pad of cloth beneath the stain absorbs any excess of the chemical

Stretch the stained portion of the garment over a bowl of clean water and apply the chemical with a medicine dropper, as shown in Figure 1. The chemicals may be rinsed out quickly by dipping in the clean water. Another method is to place the stained portion over a pad of folded cloth and apply the chemical with a glass rod as shown in Figure 2. The neutralizing must be thorough, and should be followed by rinsing in several changes of water.

The chief difficulties encountered by the inexperienced are ring formation and roughening of the fabric. Rings are caused by the excess dressing of the fabric which runs back into the edge of the damp portion and is deposited there as the fabric dries. They are overcome by skill in handling. After a spot is removed it is well to go over it lightly with a moist sponge or cheesecloth, absorbing the surplus liquid and barely dampening the surrounding fabric enough to spread the dressing out in an irregular, indistinct line. It is sometimes helpful to go over the spot with a piece of cheesecloth moistened in denatured or wood alcohol. Do not have the cloth too moist, as some colors are affected by alcohol. Rapid drying is always a wise precaution in all cases of stain removal where there is danger of ring formation. A fan or a hair drier can be used to good advantage or the garment may be hung where a good breeze strikes it. If it is impossible to prevent rings by these methods, it may be necessary to wash the garment or to dip it in gasoline. This gasoline dip is the remedy generally used by commercial cleaners (see p. 3).

A roughened fabric is due, of course, to too hard and too much rubbing. Only practice can bring the light touch which is part of the skill of an experienced cleaner. The use of a medicine dropper as described is a great advantage.

METHODS OF TREATING INDIVIDUAL STAINS

In cases where the nature of the stain is not known it should be first sponged with cold water, provided that the fabric is not injured by water (see p. 6). Hot water should be avoided in treating unknown stains until after other substances have been tried, since it will set many stains and make their removal more difficult. If the stain is not removed by cold or warm water, chemicals should be applied.

ACIDS

With the exception of nitric acid, acids do not generally produce stains upon white fabrics but often even in dilute form change or destroy the color of dyed materials. Most acids do, however, dissolve or weaken textile fibers, especially those from plants. Acid spots on textiles, therefore, should be removed at once by water or neutralized by some alkaline solution. Use one of the following:

1. **Water.**—If the material is washable, rinse the spot several times in a large volume of water. This checks the action of the acid, but usually has no effect upon any discoloration due to it.

2. **An alkaline substance.**—Apply a weak alkali to the acid spot. The alkali forms a salt with the acid, and this must be removed later by rinsing or sponging with water. The acid should be neutralized completely with the alkali or the discoloration may reappear after a while. To determine when the acid spot is completely neutralized, touch it with a piece of litmus paper, moistened with pure water. Litmus paper, which may be purchased at the drug store, is turned red by acids and blue by alkalis. If litmus paper is not available, touch the spot with the tongue. If alkaline, it will taste bitter; if acid, it will taste sour. Any of the following may be used to neutralize an acid spot:

Ammonia. If the spot is slight, neutralize it by holding it in the fumes from an open bottle of strong ammonia solution. This is a good method to use if the fabric water spots easily; otherwise the ammonia solution may be applied directly. However, some dyes are affected by ammonia. To guard against this, have dilute acetic acid or white vinegar convenient and apply if there is an undesirable color change.

Sodium bicarbonate (baking soda). Sprinkle this on both sides of the stain, moisten with water, and allow to stand until the acid is neutralized (at that point the effervescence will cease). Remove the excess by rinsing with water.

Ammonium carbonate. Apply in the same way as sodium bicarbonate or use a 10-per-cent solution.

ALKALIS

Dilute alkalis have little effect on cotton and linen, but strong alkalis cause the fibers to swell and become yellow and the cloth to contract. Wool and silk, on the other hand, are yellowed or destroyed by alkalis even in dilute solutions. The color of any fabric may be changed or destroyed even though the fiber is not noticeably affected by the alkali. It is important, therefore, to neutralize alkali spots at once. Use any of the following agents:

1. **Water.**—If the material is washable, rinse thoroughly with water. This is generally sufficient in the case of such alkalis as washing soda and ammonia.

2. **A mild acid.**—Apply the acid with a cloth until the fabric changes back to its original color, or until the stain is slightly acid as shown by its reaction to litmus paper or by the taste. Then rinse the treated spot thoroughly in water. In the case of colored goods rub the spot dry, using a piece of the same material as the stained fabric, if possible. Use any of the following mild acids:

Lemon juice. Squeeze the juice on the stain. As long as the spot remains alkaline the juice is bright yellow in color, but when the spot becomes acid the color disappears almost entirely. Apply the lemon juice until this color change takes place.

Vinegar. If the vinegar leaves a spot, sponge with water.

Acetic acid. Apply a 10-per-cent solution of acetic acid to the stain and remove the excess by rinsing or sponging.

BLOOD

Hot water will set the protein in blood stains and therefore should never be applied until after treatment with cold or lukewarm water. Use any of the following agents:

1. **Cold or lukewarm water.**—If the material is washable, soak the blood stains or rub them in the water until they turn light brown in color; that is, until most of the coloring matter is dissolved. Then wash the material in hot water. For stains on silk or wool, sponge with cold or lukewarm water (see p. 6).

2. **Ammonia solution.**—If the material is washable, soak in a solution containing about 1 ounce (2 tablespoons) of household ammonia to 1 gallon of water, until the stains are loosened. Then wash in the usual manner. For old stains ammonia is somewhat more satisfactory than soap.

3. **Hydrogen peroxide.**—Sponging with a little hydrogen peroxide (see p. 5) often will remove the last traces of blood stains after the main part has been removed by cold or lukewarm water, as described

above. This agent can be used on all fibers provided it does not injure the color of the material.

4. **Javelle water.**—Use Javelle water (see p. 4) only as a last resort and not on wool or silk.

5. **Starch.**—Raw starch mixed to a paste with cold water may be used for stains on thick materials, such as flannel and blankets, which can not conveniently be soaked in water. Apply the paste thickly to the stain and brush it away when it becomes dry. Repeat the application until the stain is removed.

BLUING

Three types of laundry bluing are in common use—ultramarine, Prussian, and aniline. Since they differ chemically, spots due to them require different treatment. It is not difficult to determine to which type a blue belongs, and methods for doing this are suggested under the three following headings:

ULTRAMARINE BLUE

The commercial blues which come in balls or blocks with directions to wrap them in a piece of flannel or other cloth and shake them about in the water to be blued are generally ultramarine. This is a finely divided, insoluble substance, which remains suspended in the water if it is stirred sufficiently but which settles on long standing. Use any of the following in removing stains caused by ultramarine blue:

1. **Cold water.**—Soak fresh stains or rinse them in an abundance of cold water.

2. **Soap and water.**—Wash the stains as in ordinary laundering, with an abundance of soap, and rub thoroughly. This treatment will remove stains which are not removed by soaking.

3. **Dilute acid.**—Hydrochloric acid, U. S. P., diluted with 4 times its volume of water; or acetic acid, 10-per-cent solution, will dissolve heavy stains of this kind. Rinse the material thoroughly after treatment with the acid.

PRUSSIAN BLUE

The liquid bluing used commonly in the home laundry is in most cases a soluble variety of Prussian blue, commercially known as Chinese blue or soluble blue. It is greenish blue in color and soluble in water. To determine whether a bluing is of this kind, place a few drops in a glass, add a small quantity of a dilute solution of lye, potash, or washing soda, and warm by holding the glass in boiling water. A flaky, reddish-brown substance (ferric hydroxide) will form when Prussian blue is present.

Prussian or Chinese blue is sometimes the cause of yellow discolorations or spots upon white clothes. If the clothes are not rinsed free from strong soap, washing soda, or other alkali used in washing before they are blued with Prussian blue, the alkali remaining on the clothes reacts with the bluing and forms ferric hydroxide, which is deposited upon the clothes. This is set by subsequent drying and ironing, and is chemically identical with iron rust. For methods of removing these stains see "Iron rust," page 19.

Clothes are occasionally overblued with Prussian, as with other bluings, or may become streaked with the bluing if it has not been mixed evenly with the water. To overcome this condition the following treatment is recommended:

1. **Cold water.**—Rinse the stains in an abundance of cold water. This is effective only for very fresh stains.

2. **Boiling water.**—If cotton or linen, boil the material until the stains disappear. Excessive boiling, however, tends to yellow fabrics if there is soap or other alkaline substances present.

ANILINE BLUES

The aniline or coal-tar blues probably are used less commonly in the household than the other blues, but are employed frequently in commercial laundries. They are sold usually in the form of small crystals or of a powder having a dark-blue or iridescent color and are soluble in water, being in this respect different from ultramarine blue. The fact that alkali gives no precipitate with them distinguishes them from Prussian blue. Stains from aniline blues may be removed by the same methods used for those from Prussian blues.

BUTTER AND BUTTER SUBSTITUTES

Stains from butter and butter substitutes are essentially grease spots, although they contain, besides the fat, small quantities of salt, casein, and sometimes coloring matter. Since the salt and casein usually are carried away mechanically when the fat is removed, the reagents and methods for removing butter spots are the same as for spots from any solid or semisolid fat (see "Grease and oils," p. 15). The coloring matter is also removed by the grease solvents.

CANDLE WAX (COLORED)

Candle-wax stains usually consist of paraffin colored with pigment or dye. Remove the paraffin as completely as possible (see "Paraffin or paraffin wax," p. 24). Then dissolve the dye remaining on the fiber by sponging with wood alcohol. These also are effective: Carbon tetrachloride, chloroform, acetone, or benzol (see p. 3).

CANDY

Candy stains are due to the sugar sirup and any coloring matter or chocolate which may be present.

1. **Laundering.**—If the material is washable, ordinary laundering is sufficient.

2. **Water.**—Sponge with clear warm water in other cases. If dye or chocolate stains remain, follow instructions given under "Dyes and running colors," page 13 and "Chocolate and cocoa," page 12.

CHEWING GUM

Chewing gum usually contains a gum known as chicle which has been boiled down, flavored, and sweetened. Resins of various kinds may replace the chicle.

1. **Water.**—If the material is washable, soften the gum stain with egg white and then wash.

2. Carbon tetrachloride.—Prolonged treatment with carbon tetrachloride is usually satisfactory, although it may be necessary to remove the traces of sugar by sponging with water. Treatment alternately with carbon tetrachloride and water is often effective.

CHOCOLATE AND COCOA

Stains from chocolate and cocoa are composed of fat, resinous coloring matter, fibrous material, starch, sugar, and sometimes milk solids. Chocolate and cocoa prepared as beverages differ from cake chocolate in containing a larger proportion of milk and less fat, but none of these stains are set by hot water. Part of the stains from cake chocolate, confectionery, frosting, and the like, can be scraped off with a dull knife.

1. Soap and hot water.—If the material is washable, this is often all that is necessary, but Javelle water (see p. 4) may be used on cotton or linen to remove any persistent stain.

2. Wood alcohol and ammonia.—Soak the stained portion of the fabric in wood alcohol made alkaline with ammonia solution. This is a particularly effective method.

3. Grease solvents.—If the fabric is not washable, grease solvents (see p. 3) will dissolve the fatty contents of the stain and the remainder can be removed by hydrogen peroxide (see p. 5).

COFFEE

The brown stains from coffee are due, at least in part, to certain compounds formed in the roasting process, which are soluble in water. Alkalis, such as soap, Javelle water, washing soda, ammonia, and the caustic alkalis, change the color of coffee stains to a bright yellow. The stains are not more difficult to remove after this change, although the treatment with alkali may cause a stain to appear much more distinct than before. Fresh coffee stains usually are not difficult to remove, but the last trace of old stains sometimes proves resistant. Cream in the coffee often necessitates the use of grease solvents in addition to other reagents. If the fabric is washable, use method 1, 2, 3, or 4; if not washable, use method 5, 6, or 7.

1. Soap and water.—Fresh stains and most old ones on washable materials can be removed by ordinary laundering. A slight trace sometimes remains in the case of very heavy or old stains. Drying the material in the sun will frequently remove these or a bleaching agent (see p. 4) may be employed.

2. Boiling water.—Pour boiling water on the stain from a height of 2 or 3 feet. This is effective upon stains which are not more than a few hours old.

3. Potassium permanganate.—See page 5.

4. Javelle water.—This agent (see p. 5) is effective in some cases in removing stains which remain after treatment with soap and water but is less satisfactory than potassium permanganate. Do not use Javelle water on wool or silk.

5. Cold or lukewarm water.—If the stains are on wool or silk material, sponge with cold or lukewarm water. If a grease spot from the cream remains after the spot has dried, remove it by the use of grease solvents (see p. 3).

6. **Damp cloths and a hot iron.**—Fairly good results are obtained in removing small coffee stains from light-colored silk material by placing the stain between clean, damp cloths and pressing the whole with a hot iron.

7. **Hydrogen peroxide.**—Sponge nonwashable materials with a very little clear water and then use hydrogen peroxide solution (see p. 5).

DYES AND RUNNING COLORS

As the dyes of textiles differ greatly in chemical composition and as it is impossible in most cases to know the character of the color, different methods must be tried, beginning with the simplest. It is impossible to remove some of these stains entirely. Each of the agents named below is satisfactory in some cases, but it should be remembered that they are not guaranteed to be successful for all stains.

1. **Water and sunlight.**—If the material is washable, rinse the stains in cold or warm water, or soak them for 10 to 12 hours if necessary, and then dry in the sun. Repeat the treatment if the stains are not removed entirely the first time. Spots on woolen and silk materials sometimes may be removed by soaking or washing in cold water.

2. **Hydrosulphite.**—One of the hydrosulphites (see p. 5) is the most satisfactory for general purposes.

3. **Javelle water.**—Do not use Javelle water (see p. 4) on wool or silk.

4. **Hydrogen peroxide.**—Make hydrogen peroxide slightly alkaline with ammonia solution and use particularly for stains on white silk or wool. Soak the stains in this solution until they disappear and then rinse thoroughly (see p. 5).

EGG

The chief constituents of egg stains are albumen, or egg white, and fat, of which the yolk contains about 33 per cent. A yellow pigment is also present in the yolk. Heat, which coagulates albumen, renders egg stains somewhat difficult to remove; therefore hot water should never be applied first. Sometimes a large part of the stain hardens on the surface of the material and may be scraped off with a blunt knife. Use cold water followed by one of these agents:

1. **Hot water and soap.**—If the material is washable, use these as in ordinary laundering.

2. **A grease solvent.**—Allow the stained place to dry after being sponged with cold water. Then apply the grease solvent (see p. 3).

FLY PAPER (STICKY)

See " Resins and resinous substances," page 25. Carbon tetrachloride and benzol are particularly effective.

FRUITS AND BERRIES (COOKED)

The stains of cooked fruits, including small fruits and berries, are somewhat different in character from those of the same fruits when fresh. More sugar usually is present, and the chemical nature of the tannin compounds and coloring matters apparently is altered in some way by the cooking. In many cases these changes render the stains much easier to remove than those of fresh fruit, and they often disappear during ordinary laundering. Stains from some cooked fruits, however, especially those that are dark red and purple, are similar to those from fresh fruit in being set by alkaline substances. Use one of the following agents:

1. **Boiling water.**—If the material is washable, use method 1 under "Fruits and berries (fresh)."

2. **Warm water.**—Sponge delicate fabrics with warm water.

FRUITS AND BERRIES (FRESH)

Most fruits contain coloring matter which often causes persistent stains on textiles. Practically all fruit stains, when they are fresh and still moist, can be removed with boiling or even warm water. After they have dried they become much more difficult to remove. This is true especially of stains from peaches and from red or purple berries. (For "Pokeberry" stain, see p. 25). Such stains in many cases are set by soap and other alkaline substances, the red color changing to a green or blue and becoming much more resistant to treatment. Some fruit stains may safely be attacked with soap and water; but as the majority are set by alkalis, it is better to avoid the use of soap on all fresh-fruit or berry stains.

The citrus fruits, such as grapefruit and lemon, often produce very persistent stains. These develop markedly if the fabric is pressed with a hot iron before being washed. Although such stains are sometimes removed by ordinary laundering, bleaches may be necessary. Potassium permanganate (see p. 5) is particularly effective. The color of some materials may be affected by the acids present in fruits such as these. However, the color can generally be restored by the methods used for acid stains (see p. 8).

Fresh fruit stains are more difficult to remove from silk and wool fabrics, although the stable hydrosulphites are valuable agents if the material is white. Oxalic-acid solution can also be used on such white fabrics. Sponging with a 10-per-cent solution of acetic acid is sometimes helpful when stronger chemicals can not be used on very delicate colored fabrics. Stains remaining on silk or wool (white or dyed with fast colors) after sponging with warm water frequently can be removed with a little hydrogen peroxide, made slightly alkaline with ammonia.

1. **Boiling water.**—If the stain is on white or fast-colored washable material, stretch the stained material over a bowl or other vessel, hold it by a string or an elastic band, if necessary, and pour boiling water upon it from a teakettle held at a height of 3 or 4 feet, so that the water strikes the stain with some force. With some stains, especially those in which fruit pulp is present, a litle rubbing alternated with applications of boiling water is helpful. A stain remaining after this treatment oftentimes can be bleached out by hanging the wet material in the sun to dry.

2. **Lemon juice and sunlight.**—Stains remaining after treatment with boiling water can often be bleached by moistening with lemon juice and exposing to the bright sunlight.

3. **Acetic or oxalic acid.**—A stain which turns blue or gray and can not be removed readily by boiling water sometimes can be loosened by moistening with acetic acid (10-per-cent solution) or oxalic

acid (see p. 5). This restores its original color and renders it more easily soluble in the boiling water. If necessary, apply the acid several times, alternating with boiling water.

4. **Hydrosulphites.**—Stable hydrosulphites (see p. 5) are very satisfactory for removing fruit stains from any white fabrics.

5. **Javelle water.**—Javelle water (see p. 4) is effective for white cotton or linen materials but should not be used on wool or silk.

6. **Potassium permanganate.**—See page 5.

7. **Potassium acid oxalate.**—This is sometimes sold under the name of " salts of lemon " or " salts of sorrel." Treat the stains with boiling water and then boil them in the acid oxalate solution. A 3-per-cent solution made by diluting a saturated solution (which contains about 6 per cent of the oxalate at ordinary temperature) with an equal volume of water is satisfactory.

GLUE

Glue is soluble in water, but if it has become thoroughly dried, long soaking is necessary before it becomes soft enough to dissolve completely. Use one of the following agents in removing glue spots:

1. **Water.**—If the material is washable, soak the spot in warm water. Occasionally it is necessary to boil the stained material.

2. **Acetic acid.**—Sponge the spot with dilute acetic acid using absorbents such as clean blotters or a pad of soft cloth. White vinegar may be used instead of the acid but is not always so satisfactory.

GRASS, DANDELION, AND OTHER FRESH GREEN FOLIAGE

The green stains from grass or fresh foliage are due to chlorophyll, the coloring matter present in green plants. Use one of the following agents in removing stains of this character:

1. **Hot water and soap.**—If the material is washable, use hot water and soap as in ordinary laundering, rubbing the stain vigorously. Remaining traces may be bleached out with Javelle water (see p. 4) if the material is cotton or linen, or potassium permanganate (see p. 5). These bleaches will remove the dark-brown stains caused by the juice of the dandelion.

2. **Ether or wood or denatured alcohol.**—Apply by sponging (see p. 6). This is useful on fabrics that laundering might injure.

GREASE AND OILS

Fresh grease spots may consist of the pure fat or oil. Old grease spots or stains from automobile, wheel, or machine greases, usually contain more or less dust, dirt, or fine particles of metal. (For road oil and creosote oil, see p. 27.) Sometimes it is possible to scrape or wipe much of the adhering grease from a stained material. After this has been done there is a choice of three general methods of treating the stain itself: Wash it with soap and warm water to remove the grease; or absorb the grease with dry substances; or dissolve the grease in an organic liquid. Use one of the following agents:

1. **Warm water and soap.**—Grease spots usually can be removed from washable materials with warm water and soap as in ordinary laundering if care is taken to rub the particular spot thoroughly. Soaps containing naphtha or kerosene are efficient.

2. Absorbents.—Use blotting paper, fuller's earth, brown paper, French chalk, powdered magnesia, or white talcum powder for fine materials; corn meal or salt for carpets, rugs, and other coarse materials. The use of absorbents generally is effective only on spots of grease or oil unmixed with particles of dirt or metal. The advantages of using them are that they do not wet the fabric or leave rings as often happens when water or grease solvents are employed.

3. Organic solvents.—Carbon tetrachloride, chloroform, ether, gasoline, naphtha, and benzol (see p. 3) are effective in the removal of common grease and cedar and other vegetable oils. Carbon tetrachloride is best for removing cod-liver oil, although a bleaching agent (see p. 4) may also be necessary if these stains are old.

Place a pad of clean cloth or a white blotter beneath the stain and change it as soon as it becomes soiled. Sponge the stain with a clean cloth, preferably a piece like the stained material, moistened with the solvent. To prevent the spreading of the grease and solvent, it is best to use small quantities of the solvent at a time and to work from the outside of the spot toward the center. It is well also to surround the stain with a ring of French chalk or other absorbent mentioned in method 2. After applying the solvent rub the spot with a clean cloth until it is thoroughly dry.

In removing grease spots which contain dirt or fine particles of metal, more rubbing and a larger quantity of solvent are necessary. It is best to apply the solvent from the wrong side of the material so that the particles will be washed mechanically from the fibers onto the pad of cloth placed underneath. If the spot does not yield to this treatment, immerse it in a small bowl of the solvent, and brush it gently with a small, soft brush. The brushing serves to loosen the insoluble particles, which then fall to the bottom of the bowl.

Generally if the stained place must be dipped in the solvent, it is more satisfactory to immerse the whole article finally in clean solvent, which prevents the formation of rings (see p. 7). If sufficient solvent is not at hand for this, the ring usually can be removed by careful and patient sponging with small quantities of fresh solvent. Replace the cloth, pads, or blotter, often as suggested above, and work from the wrong side of the material.

A paste made by mixing the solvent with French chalk, magnesia, or other white absorbent is often used. Spread the paste over the spot, leave it until thoroughly dry, and brush it off. Repeat this treatment if necessary. The spreading of the solvent and the formation of a ring will be avoided to a considerable extent in this way. The method is especially useful for cleaning light-colored unwashable materials, laces, and the like.

GUMS

Many gums such as gum arabic and cherry-tree gum are soluble in water. For other so-called gums, see "Chewing gum," page 11, and "Resins and resinous substances," page 25.

ICE CREAM

Ice cream stains are similar to those of milk or cream, except that they always contain sugar, sometimes eggs, and often chocolate, fruit, or flavorings. If stains from these added materials persist after the ice cream itself has been removed, special methods must be used, such as for "Fruits and berries (fresh)," page 14; "Fruits and berries (cooked)," page 13; "Coffee," page 12; "Chocolate and cocoa," page 12. Use one of the following agents:

1. **Soap and water.**—If the material is washable, use soap and water for stains in which no highly colored fruit or other substance is present.

2. **Cold or lukewarm water.**—Sponge the stains thoroughly with water (see p. 6). If, on drying, a grease spot from the cream remains, remove it by the methods suggested for grease spots (see p. 15).

INK

INDIA INK

Genuine Indian ink is finely divided carbon mixed with gum and formed into a cake which, when used, is rubbed up with water. Drawing inks often contain shellac and borax in addition to the gum. Finely divided carbon or colored pigments may be added. If these have penetrated the fabric deeply they are impossible to remove completely. Wood or denatured alcohol, glacial acetic acid, chloroform, or gasoline (try in the order named) are helpful in dissolving the waterproofing ingredients and mechanically removing the carbon. See "Printing ink," page 18.

MARKING INK

So-called indelible or marking inks are of two common types: Those with an organic dye, usually aniline black, as a basis, and those containing silver nitrate or other silver compound.

Ink of the aniline-black type may be recognized by the directions for its use, which generally state that the articles marked with it must not be ironed until after they have been washed. Aniline-black inks are remarkably fast, and it is practically impossible to remove them after they have once become dry. None of the methods given for the removal of silver-nitrate ink stains are effective on aniline-black ink stains, nor do most of the methods used for ordinary writing-ink stains give satisfactory results.

Ink of the silver-nitrate type may also be recognized generally from the directions for its use, which state that articles marked with it must be laid in the sun or pressed with a warm iron before they are washed. This is to bring about the precipitation of metallic silver, which gives the black or brown color to the marks. Use one of the following agents in removing stains from silver-nitrate inks:

1. **Iodine and sodium thiosulphate ("hypo").**—Moisten with a few drops of tincture of iodine, sponge out and then remove with a solution of sodium thiosulphate made by dissolving several crystals in one-half cup of water.

2. **Corrosive sublimate (poison).**—A dilute solution of this chemical is very effective, but it is so poisonous that its use is not recommended unless extra precautions are taken to keep it from the fingers and to remove all traces of it from the vessels used.

3. **Javelle water.**—If the stain is on white cotton or linen, Javelle water (see p. 4) may be applied repeatedly until the color of the spot disappears. Then soak the stained place in ammonia solution to remove the silver chloride formed.

PRINTING INK

The coloring matter of black printing ink consists of finely divided carbon, usually in the form of lampblack. This is suspended in linseed oil with resin, turpentine, etc. Colored printing inks are obtained by adding colored pigments instead of carbon. Stains from ink of this type are very similar to paint stains. Use one of the following agents for removing printing-ink stains:

1. **Soap and water.**—If the material is washable, fresh stains may be removed by applying an abundance of soap and water and rubbing thoroughly.

2. **Lard.**—Rub the stained place with lard and work it well into the fibers. Follow with soap and water, as in method 1.

3. **Turpentine.**—Soak for a few minutes in turpentine and then sponge out with chloroform, ether, or wood alcohol.

WRITING INK

The coloring matters commonly used in writing inks include the following: Combinations of logwood or nutgalls with ferrous or ferric salts or with salts of other metals; aniline dyes, which are used either alone or with coloring matters of the type mentioned above; finely divided carbon in the form of lampblack. Colored inks are usually solutions of aniline dyes. Gums, sugar, or glycerine often are added to thicken an ink and hold the coloring matter in suspension, and phenol may be used to keep it from molding.

On account of the differences in the composition of writing inks, it is impossible to find agents which are equally effective in removing all ink spots. Each of the agents mentioned below is satisfactory with some type of ink. For an ink spot of unknown composition, it is necessary to try various agents, beginning always with the simplest and that least likely to injure the fabric.

If the ink has been spilled on the carpet, first apply absorbents as in method 1. These are more satisfactory than the following methods which will remove the color from the carpet unless used very carefully. Try repeated applications of oxalic acid (method 4) or potassium permanganate (method 6), or rub with the cut surface of a lemon, squeezing on the juice and rinsing between applications with a clean, wet cloth until no more ink can be removed. Rub the spot then with a clean, dry cloth. After the carpet is dry, brush up the nap with a stiff brush or a cloth. For ink stains on other fabrics, use one of the following:

1. **Absorbents.**—To a moist stain apply corn meal, salt, French chalk, fuller's earth, magnesia, or talcum powder to remove any ink not absorbed by the fibers and to keep it from spreading. For a large ink spot, apply one of these substances before trying other agents. Work the absorbent around with a blunt instrument and renew it when it becomes soiled. When the dry absorbent fails to take up more ink, make it into a paste with water and apply again.

2. **Soap and water.**—If the fabric is washable, soap and water as in ordinary laundering is satisfactory for some types of ink.

3. **Milk.**—Soak the stains for a day or two, if necessary, changing the milk as it becomes discolored. Pasteurized milk usually is not so satisfactory for this purpose as milk that has not been heated.

4. **Oxalic acid.**—Soak the stains for a few seconds in a saturated solution of oxalic acid (see p. 5), then rinse in clear water, and finally in water to which a few drops of concentrated ammonia solution have been added.

5. **Potassium acid oxalate.**—Soak the stains for several hours, if necessary, in a solution of 2¼ teaspoons of potassium acid oxalate ("salts of lemon" or "salts of sorrel") dissolved in one-half pint of water.

6. **Potassium permanganate.**—Potassium permanganate (see p. 5) is satisfactory for stains on many delicate fabrics as well as on ordinary materials.

7. **Javelle water.**—Do not use Javelle water (see p. 4) on silk or wool.

8. **Commercial ink removers.**—These are generally satisfactory if the directions furnished with them are followed and the excess of the substance is removed by thorough rinsing in clean water.

9. **Hydrogen peroxide.**—See page 5.

10. **Acids.**—Citric or tartaric acid (2 tablespoons to one-half cup of water), lemon juice, or dilute hydrochloric acid may be used. Apply the citric or tartaric acid in the same way as oxalic acid, method 4. In the case of lemon juice, keep the stain moistened and exposed to the sun. In the case of hydrochloric acid, moisten the stain with it and then rinse thoroughly.

11. **Hydrosulphites.**—Use as directed on page 5.

12. **Sodium perborate.**—Use cold in saturated solution. Soak the stain in it for one or two days, if necessary. This is effective in removing some red ink stains.

IODINE

Iodine dropped on unstarched material makes a brown or yellow stain. The presence of starch causes the stain to become deep blue or black, and the heat of ironing sometimes turns it a dark brown.

1. **Soap and water.**—If the material is washable, soap and water will often remove a fresh stain.

2. **Denatured or wood alcohol.**—Sponge the material (see p. 6). This agent can often be used on materials which water would injure.

3. **Ammonia solution.**—Sponge the stain with a dilute solution of ammonia (see p. 6).

4. **Sodium thiosulphate ("hypo").**—Immerse the stains in a solution containing 1 tablespoon of this chemical to 1 pint of water.

5. **Sodium sulphite.**—Apply in same way as sodium thiosulphate.

IRON RUST

Iron-rust stains often come from rusty clothes wringers or lines, or from the careless use of laundry bluing of the Prussian-blue type (see p. 10). Use one of the agents below for iron-rust stains on white washable materials. In the case of colored materials, try the effect of the agent first on a sample or in an inconspicuous place.

1. **Lemon juice.**—Spread the stained place over a vessel of actively boiling water and then squeeze lemon juice on the stain. After a few minutes, rinse the fabric, and repeat the process. This method is rather slow, but does not injure delicate white cottons or linens.

2. Lemon juice and salt.—Sprinkle the stain with salt, moisten with lemon juice, and place in the sun. Add more lemon juice if necessary.

3. Potassium acid oxalate.—Immerse the stain in a solution of one-half teaspoon of potassium acid oxalate ("salts of lemon" or "salts of sorrel") to 1 pint of water. More crystals may be added if necessary. Boil until the stain disappears, and then rinse thoroughly.

4. Oxalic acid.—Prepare a saturated solution of oxalic acid (see p. 5), spread the fabric over a bowl of hot water and apply the solution to the stains, or put the crystals of the acid directly on the fabric and moisten with hot water. Rinse in hot water, and repeat until the stains disappear.

5. Tartaric acid.—Boil the stained place in a solution of 1 teaspoon of the acid to 1 pint of water until the stain disappears, and rinse thoroughly.

6. Cream of tartar.—Boil the stained place in a solution containing 4 teaspoons of cream of tartar (potassium acid tartrate) to 1 pint of water. Rinse thoroughly.

7. Citric acid.—Immerse the stain in a solution of 1 teaspoon of citric acid to 1 pint of water and boil for 15 minutes or longer. Rinse thoroughly.

8. Hydrochloric acid.—Dilute the strong acid (U. S. P.) with four times its volume of water. Spread the stained place over a bowl of hot water and apply the acid drop by drop until the stain turns bright yellow. Then immerse at once in hot water and rinse thoroughly. Repeat the treatment if necessary. Add a little ammonia solution or borax to the last rinse water to neutralize any acid which may remain in the goods.

9. Hydrofluoric acid.—This acid and its salts are excellent agents for this purpose but are so corrosive that they must be employed and handled with a great deal of care. Many of the commercial rust-stain removers contain such substances, and it is often better to purchase them in that form.

LEATHER

The stains caused by the rubbing of leather on textiles probably contain tannin compounds and are difficult to remove. In the case of stains from automobile seats, the varnish is the chief material to be removed (see "Paints," p. 22). The following agents are satisfactory in some cases:

1. Soap and water.—If the fabric is washable, use an abundance of soap and rub thoroughly.

2. Potassium permanganate.—See page 5.

LIME (SLAKED)

Allow the spots to dry, brush carefully, and treat in the same way as alkali stains (see p. 9).

LINSEED OIL

Organic solvents, such as acetone, carbon tetrachloride, and benzol, are very effective (see p. 3).

MEAT JUICE OR GRAVY

Stains from meat juice are similar to those from blood (see p. 9). Boiling water sets them and should not be used until the protein has been removed by warm water. If grease spots remain, they can be removed by the methods for "Grease and oils," page 15.

MEDICINES

Because of the great number and variety of substances used in medicines, it is not possible to give methods or materials for removing all medicine stains from fabrics. If the nature of the medicine is known, the remover can be chosen accordingly. For instance, a tarry or gummy medicine can be treated with the same agents as tar spots (see p. 27); a medicine containing much iron can be removed by the agents used for iron rust (see p. 19; medicines in a sugar sirup usually can be washed out with water; those dissolved in alcohol sometimes can be removed from fabrics by sponging with alcohol. Many of the medicines used in swabbing sore throats contain silver nitrate and should be treated like the marking inks containing silver nitrate (see p. 17). If the nature of the medicine stain is not known, it is necessary to try various agents until one is found which serves the purpose. Each of the following agents is satisfactory in removing some medicine stains:

1. **Boiling water.**—Pour boiling water on the stain as for fruit stains (see p. 14), or launder washable fabrics.
2. **Acids.**—Dilute solutions of hydrochloric or oxalic acid sometimes are useful for stains containing metallic salts. See "Iron rust," page 19.
3. **Wood or denatured alcohol.**—Some stains can be sponged or soaked out with alcohol.
4. **Javelle water.**—Javelle water (see p. 4) sometimes bleaches a stain that resists other treatment, but should not be used on silk or wool.

METALLIC STAINS

The tarnish of copper, brass, and other metals often stains textile materials. In removing such stains avoid the use of oxidizing agents such as bleaching powder and potassium permanganate. The following is usually effective:

1. **Dilute acids.**—Apply dilute acetic acid, hydrochloric acid, vinegar, or lemon juice. Rinse well as soon as the stain has dissolved (see "Iron rust," p. 19).

MILDEW

Mildew spots are growths of some species of molds on fabrics that have been allowed to remain damp for a time. The spots may be of various colors but often are grayish green, brown, or almost black. The growth of mildew is merely upon the surface of the material at first, but if allowed to continue it attacks and destroys the fiber itself. The spots must be treated when fresh if injury to the fabric is to be avoided. Use one of the following agents:

1. **Soap and water.**—If the fabric is washable, very fresh stains can be washed out with soap and water. Drying in the sun helps to bleach the spots.

2. **Sour milk.**—Soak the stains overnight in sour milk and then place in the sun without rinsing. Repeat the treatment several times if necessary. Slight stains can be removed in this way.

3. **Lemon juice.**—Moisten the stains with lemon juice and salt and allow them to remain in the sun. This often removes slight stains.

4. **Javelle water.**—Old stains may be bleached out with Javelle water (see p. 4), but it should never be used on silk or wool.

5. **Potassium permanganate.**—Old and persistent stains may also be removed with potassium permanganate (see p. 5).

6. **Oxalic acid.**—A 10-per-cent solution of oxalic acid (see p. 5) will remove some forms of mildew.

MILK AND CREAM

Milk stains consist chiefly of protein and fat. For removing these use one of the following:

1. **Cold or lukewarm water.**—If the material is washable, rinsing in cold or lukewarm water followed by hot water and soap is generally sufficient.

2. **Grease solvents.**—Use carbon tetrachloride, acetone, gasoline, or other grease solvent (see "Grease and oils," p. 3). For fabrics which ordinary laundering would injure, first sponge with the solvent, allow the spot to dry, and then sponge carefully with water.

MUD

Allow mud stains to dry and brush carefully before any other treatment is used. Sometimes nothing else is needed. The following agents are satisfactory:

1. **Soap and water.**—If the fabric is washable, use soap and water.

2. **Wood or denatured alcohol.**—Sponge the stains with alcohol (see p. 6).

3. **Water.**—Sponge the stains with water (see p. 6).

4. **Cut raw potato.**—For black silks of firm weave, brush thoroughly and rub the spot with a cut raw potato. This leaves a thin film of starch on the surface of the cloth, which can be brushed off when dry. This treatment is too harsh for any but rather smooth, firm goods and leaves a spot on all but black materials.

MUSTARD

Prepared mustard often contains turmeric (see p. 29) which makes such stains more difficult to remove. The following agents are usually effective for ordinary mustard stains:

1. **Soap and water.**—If the fabric is washable, use soap and water.
2. **Warm glycerin.**
3. **Hydrosulphite.**—See page 5.

PAINTS

OIL PAINTS, VARNISHES, AND ENAMELS

Oil-paint stains generally consist of a finely divided inorganic pigment, held in the fiber by drying oil. Varnish spots contain gums or resins, but usually no pigment. Enamels and some types of wood stains, generally known as varnish stains, contain both a pigment and the gums or resins of varnish. The hardening or drying of both paint and varnish stains forms a resinous solid which holds the pigment or gum firmly within the fibers and renders the removal of old stains almost impossible. Before using any agent on paint or varnish stains, it is best to scrape off as much of the stain as possible from the surface of the material. If the stain has hardened, apply the solvent on both sides and give time for it to soften. Excessive rubbing roughens the fabric. Methods 1, 2, and 3 are for fresh stains. For those that have hardened but have not oxidized in the fiber, methods 4, 5, and 6 are more suitable.

1. **Soap and water.**—If the material is washable, fresh stains are removed easily by carefully washing with plenty of soap. Older stains sometimes can be removed in this way if they are first softened by rubbing oil, lard, or butter into them thoroughly.

2. **Turpentine.**—Sponge the stains with pure turpentine or wash the whole article in it, if the spots are large or scattered. Rinse several times in fresh quantities of the solvent.

3. **Turpentine and ammonia.**—Stains which are not fresh and yet have not entirely hardened can be softened by moistening them with ammonia solution and sprinkling them with a little turpentine. Roll the article up for 15 to 20 minutes, or soak it for several hours, if necessary, and then wash with warm water and soap.

4. **Oil solvents.**—Carbon tetrachloride, chloroform, or benzol, applied in the same way as turpentine, are satisfactory. Gasoline, kerosene, and alcohol are helpful but usually less effective (see p. 3).

5. **Benzol and acetone.**—Benzol and acetone used in equal parts make a very good paint remover. Equal parts of benzol, acetone, and alcohol also make an excellent solvent. Benzol is a good solvent for the usual type of spar varnish, and wood alcohol will remove stains of shellac varnish.

6. **Sodium carbonate (washing soda).**—Boil the stains in a solution containing 3 tablespoons of washing soda to 1 gallon of water. This is successful for such fabrics as will stand the treatment.

ALCOHOL PAINTS OR STAINS

In paint of this type a pigment is suspended in alcohol with small quantities of shellac and other resinous material. The methods of removing it from fabrics differ somewhat from those for ordinary paint stains. Treatment with turpentine alone or with other oil solvents, which usually will remove ordinary paint stains, is ineffective. Use one of the following agents:

1. **Soap and water.**—If the material is washable, use for very fresh stains. (See method 1 under "Oil paints," etc.)

2. **Wood or denatured alcohol.**—If the stains are fresh, sponge them freely (see p. 6) with alcohol.

3. **Strong ammonia.**—Soak the stain for half an hour in strong ammonia and then wash, or use ammonia and turpentine as suggested in method 3 for "Oil paints," etc.

WATER-COLOR PAINTS

Water-color paints consist essentially of a pigment mixed with some substance which is soluble in water, such as glycerin. These stains are easy to remove from washable fabrics, but from materials like finished silks it is almost impossible to get out all traces. The appearance of the spots may be improved greatly, however, by method 2, 3, or 4.

1. **Soap and water.**—If the fabric is washable, both fresh and old stains can be removed in this way.

2. **Turpentine and benzol.**—Sponge the stained portion with turpentine until the water color is removed and then with benzol, if necessary, to remove the turpentine.

3. **Gasoline.**—Dip the stained portion in gasoline and rub vigorously (see p. 3).

4. **Glycerin and water.**—Sponge the stain with glycerin until the water color is removed and then with lukewarm water to remove the glycerin. In case a ring is left, treat as described on page 7.

PARAFFIN OR PARAFFIN WAX

The stains from paraffin do not spread like ordinary grease spots, but harden on the cloth, and much of the stain usually may be scraped away. For colored paraffin, see "Candle wax (colored)," page 11. For removing the part of the paraffin stain which has penetrated the fiber, use one of the following agents:

1. **Blotting paper.**—Use blotting paper and a warm iron.

2. **A grease solvent.**—If a trace of the stain remains after treatment by method 1, sponge the stain carefully with a solvent (see "Grease and oils," method 3, p. 15).

PENCIL MARKS

LEAD PENCIL

The marks from lead pencils contain graphite, which is insoluble. The methods of removing pencil marks from textiles are the same as for removing tin-foil marks (see p. 28). A soft eraser sometimes can be used successfully in effacing the marks, especially on stiff or starched materials.

INDELIBLE PENCIL MARKS

Indelible pencil marks also contain graphite, and a dye which usually is not apparent until the marks are moistened. If the stains are known to be indelible pencil marks, do not wet them as this spreads the dye and makes them more difficult to remove. The dye may vary with different makes of pencils, but the following are usually effective:

1. **Organic solvents.**—If the stain has not been moistened it can usually be removed by soaking in denatured or wood alcohol, ether, or acetone (see p. 3). Graphite marks may remain which can be removed by sponging with soap and water.

2. **Javelle water.**—Javelle water (see p. 4) will usually bleach out the dye but can be used only on white cotton or linen.

3. **Potassium permanganate.**—This also is an effective bleach (see p. 5) in removing the dye.

PERSPIRATION

Colors changed by perspiration are very difficult to restore, but treatment may be found satisfactory in some cases (see "Dyes and running colors," p. 13 and "Acids," p. 8). Though the perspiration of the body is usually acid, old stains may be alkaline due to decomposition. For treating colors changed by this, see "Alkalis," page 9. The yellow stains sometimes produced upon white material by perspiration are removed by the following agents:

1. **Soap and water.**—If the material is washable, exposure to the sun after using soap and water helps to bleach out the stains.
2. **Hydrogen peroxide.**—See page 5.
3. **Javelle water.**—Do not use Javelle water (see p. 4) on wool or silk.
4. **Potassium permanganate.**—See page 5.

POKEBERRY

Besides the red color of the juice, there is present in most pokeberry stains a green color, probably chlorophyll. In removing such stains these two colors must be dealt with. If the fabric is washable, to take out the red color use boiling water as for "Fruits and berries (fresh)" (see p. 14); otherwise sponge with warm water. Use the methods given for "Grass," etc. (p. 15) for removing any green color that remains.

RESINS AND RESINOUS SUBSTANCES

Resinous substances are best removed from textiles by means of organic solvents, the particular solvent most effective depending on the nature of the material which has caused the stain. Use one of the following: Turpentine, benzol, carbon tetrachloride, chloroform, wood or denatured alcohol, ether, kerosene, gasoline. Sponge the stain (see p. 6) with the solvent or dip the spot in it and rub.

SALAD DRESSINGS

Salad dressings usually contain oil, vinegar, or lemon juice, and condiments. They may contain egg or cream also. If egg or cream is present, hot water must not be used. For discoloration owing to the acid of the vinegar or lemon juice, treat in the same way as acid stains (see p. 8). Use one of the following agents for salad-dressing stains:

1. **Soap and water.**—Sponge delicate washable materials with lukewarm water, using soap if the material is not harmed by it.
2. **Grease solvents.**—Apply as suggested on page 15 after sponging the stained place with water and drying it.

SCORCH

Scorch on cotton and linen sometimes can be removed, if the fibers are not actually burned. Wool and silk usually can not be restored to their original condition after being scorched, but wool may be improved by brushing with emery paper. For removing slight scorch stains from cotton and linen, use one of the following:

1. **Soap and water.**—If the fabric is washable, soap and water are sufficient to remove very slight stains.
2. **Water and sunlight.**—Wet the spot with water (or soap and water) and expose to the sun for a day, or longer if necessary. The scorch disappears more rapidly if the material is moistened first.
3. **Hydrogen peroxide.**—Light scorch stains can be removed from any white fabric as follows: Dampen a white cotton cloth with hydrogen peroxide and place over the stain. Place a clean dry cloth

over this to protect the iron and then iron with a medium warm iron, replacing the top cloth if the hydrogen peroxide soaks through. Repeat the operation if necessary. *Precaution:* Do not iron directly on the cloth moistened with peroxide or on the moist fabric after the dry cloth has been removed. If this is done, the iron leaves rust stains on the garment.

SHOE DRESSINGS

BLACK SHOE DRESSINGS

The most common kinds of black shoe polish are the pastes, consisting chiefly of lampblack moistened with turpentine or water, polishing waxes, and sometimes a black dye; and the liquid dressings containing black dye, but generally no lampblack, and a polishing agent such as waxes or shellac. Use one of the following agents in removing stains caused by black shoe polishes:

1. **Soap and water.**—If the material is washable fresh stains made by one of the paste dressings can be removed by sponging or washing thoroughly with an abundance of soap (see p. 6).

2. **Turpentine.**—Use only for the pastes containing turpentine. This may be detected by the odor. Immerse the stained places and rub gently in turpentine.

3. **Potassium permanganate.**—Use potassium permanganate (see p. 5) for stains from the black liquid dressing. First remove as much of the stain as possible by sponging or washing as in method 1.

4. **Javelle water.**—Javelle water (see p. 4) is also useful for stains, from black liquid dressing. Do not use on silk or wool.

TAN SHOE DRESSINGS

The common tan leather dressings consist of either a liquid cleaning solution or a polishing wax, or both. The cleaning solution sometimes contains a considerable quantity of free oxalic acid, which may weaken a fabric seriously if allowed to remain long in contact with it. Sometimes water-soluble dyes are present also, and these make a much more persistent stain on wool than on cotton. The stain produced by the polishing waxes usually may be removed by one of the solvents suggested for "Candle wax (colored)," page 11. Use one of the following agents:

1. **Soap and water.**—Use for stains on cotton and linen.

2. **Wood or denatured alcohol.**—The stains on wool are removed more successfully by sponging (see p. 6) with alcohol, than with soap and water.

WHITE SHOE DRESSINGS

For spots caused by white shoe pastes or liquids use the following:

1. **Water.**—First sponge the spot with water (see p. 6) and when dry brush thoroughly or rub in the direction of the weave with a piece of the same material.

SOAP

When a material has not been rinsed sufficiently and is ironed with soap still present in the fiber, stains sometimes appear which resemble iron-rust stains, but usually are lighter yellow in color. Soap and water is usually sufficient to remove these. Bleaching in the sun helps to remove stains which are especially persistent.

SOOT

Soot spots, being composed of fine particles of carbon, are insoluble and must be removed mechanically from a fabric. Use one of the following agents:

1. **Absorbents.**—First brush the stain, then place on it such absorbent powders as fuller's earth, French chalk, cornstarch, corn meal, or salt. Work them around until they become soiled and brush them away. If the fabric is washable, then sponge or wash the stain with soap and water.

2. **Organic solvents.**—Chloroform, gasoline, or other organic solvents (see p. 3) may be used to rinse the soot from materials injured by washing. First brush the stain lightly or treat it with absorbent powder, as in method 1, then immerse it in the solvent and rub gently, or brush with a small, soft brush. For the treatment of rings, see page 7.

STOVE POLISH

Stove polish usually contains carbon in the form of graphite. It is difficult to remove such stains completely. The following agents are fairly satisfactory:

1. **Soap and water.**—If the fabric is washable, this method is fairly successful, especially if the soap is rubbed thoroughly on the stain.

2. **Organic solvents.**—Chloroform, gasoline, or other organic solvents (see p. 3) may be used for material injured by washing. Treat with absorbent powders as for "Soot," method 1, and then immerse the stain in the solvent. While immersed rub it gently or brush it with a small soft brush.

SUGAR SIRUPS

If the material is washable, sugar-sirup stains can be easily rinsed out with soap and water. For more delicate fabrics sponging (see p. 6) with clean water is generally effective.

TAR, ROAD OIL, CREOSOTE OIL, ASPHALT, ASPHALT PAINT, AXLE GREASE

The stains from these substances are grouped together because they are somewhat similar in their chemical composition and certain solvents may be used for all. The stains are rather difficult to remove, especially from cotton. After the oily or tarry part has been taken out, dark-colored organic or mineral impurities are likely to remain. Use one of the following agents:

1. **Carbon tetrachloride.**—Sponge the stains with carbon tetrachloride or immerse them in the liquid and rub. The latter treatment is best if the fabric is not too delicate. Follow by a thorough washing in soap and water if the fabric is washable. For stains on carpet, scrub with a cloth soaked in the solvent, changing to a fresh cloth as soon as it becomes discolored, and continuing as long as any color comes off.

2. **Carbon disulphide.**—*Caution.* This is the best general solvent for these substances but is very inflammable and poisonous. If used, it should be kept far away from any flame and the garment cleaned in a very well-ventilated place. It is better not to store the unused portions of the liquid.

3. Benzol, chloroform, or turpentine.—These may be applied in the same way as carbon tetrachloride, method 1.

4. Lard.—Rub thoroughly into the stain, then wash in hot water and soap. Repeat the treatment, if necessary.

TEA

Tea stains contain a brown coloring matter which is not difficult to remove when fresh, but which becomes very persistent when allowed to remain a long time in contact with the fiber. Stains from tea containing milk or cream are removed more easily from cottons and linens than are stains made by clear tea. Use one of the following:

1. Borax and boiling water.—If stains are on cotton or linen and only a few days old, soak them in a borax solution (one-half to 1 teaspoon of borax to 1 cup of water) and then rinse in boiling water.

2. A strong soap solution.—Use a half-inch cube of soap to each cup of water, and boil the stained material in this. Stains 2 or 3 weeks old can be removed if they are on small articles of white washable material which can be boiled in a small quantity of liquid.

3. Potassium permanganate.—Use potassium permanganate (see p. 5) for stains which resist other reagents.

4. Javelle water.—For persistent stains, Javelle water (see p. 4) is slightly less satisfactory than the potassium permanganate and can not be used on wool or silk.

5. Lemon juice and sunlight.—Keep the stains moist with lemon juice and expose them to the sun for a day or two. They will be practically removed.

TIN FOIL

The stains caused by the rubbing of tin foil, as for example when it is used to wrap stems of cut flowers, consist of finely divided particles of metal. Since these are not soluble in any chemical that would be harmless to textile fibers, they must be removed from the fabric mechanically. Use one of the following agents:

1. Soap and water.—If the material is washable, use the soap freely and rub the stain thoroughly. Sponge woolen materials.

2. Chloroform or other organic solvent.—Immerse the stained place in a small vessel of the solvent (see p. 3) and brush gently with a small soft brush or rub with a cloth.

TOBACCO

Stains from tobacco juice consist of the brown coloring matter of the tobacco plant and may contain, in addition, molasses which has been added to the tobacco for sweetening and flavoring. Treat stains from the tarry substances in the stem of a pipe in the same way as "Tar," etc., page 27. Use one of the following reagents in removing tobacco-juice stains:

1. Soap and water.—Sponge materials that can not be washed (see p. 6). If a stain on washable materials can not be completely removed by washing, bleach it in the sun. Moistening it with lemon juice makes it disappear more quickly.

2. Wood or denatured alcohol.—Traces of color remaining on wool fabrics after sponging with water can be removed sometimes by sponging with alcohol.

3. Potassium permanganate.—Use potassium permanganate (see p. 5) for stains that washing will not remove.

4. **Javelle water.**—Do not use Javelle water (see p. 4) on wool or silk.

TOMATO VINE

The stains from tomato vines contain, besides the green coloring matter (chlorophyll), a brown color which is rather persistent. Use one of the following agents:

1. **Lemon juice and sunlight.**—First wash the stains carefully, then moisten them with lemon juice and expose them to the sun for several days if necessary. This is satisfactory for stains on white washable materials.

2. **Wood or denatured alcohol.**—Sponge the stains (see p. 6) with alcohol which removes the green part of the stain. If the brown stains persist, use one of the bleaches suggested in method 3 or 4. Stains on wool or silk are practically removed by this treatment.

3. **Potassium permanganate.**—First wash the stains with soap and water or sponge with wood or denatured alcohol; then apply the potassium permanganate (see p. 5).

4. **Javelle water.**—First wash the stains with soap and water or sponge with wood or denatured alcohol; then apply the Javelle water (see p. 4). Do not use it on silk or wool.

TURMERIC

Turmeric, because of its yellow color and aromatic flavor, is used in curry powder, and oftentimes in pickles and prepared mustard. The yellow coloring matter has a special attraction for cotton. Methods 1 and 2 are for fresh stains, and methods 3, 4, and 5 for old stains.

1. **Dilute ammonia solution.**—Remove fresh stains on white materials by soaking in this reagent.

2. **Wood alcohol or chloroform.**—Soak the material in wood alcohol or chloroform.

3. **Hydrosulphites.**—See page 5.

4. **Javelle water.**—Do not use Javelle water (see p. 4) on silk or wool.

5. **Potassium permanganate.**—See page 5.

URINE

These stains are so variable in composition that it is impossible to give methods which will be successful in all cases. If the color is not destroyed but only changed, one of the methods given for acids or alkalis (see pp. 8 and 9) may be used successfully. Normal human urine is usually acid and that of herbivorous animals is alkaline.

1. **Salt and water.**—A warm solution of salt is sometimes effective and often will not destroy the color of the fabric.

2. **Hydrogen peroxide.**—Add hydrogen peroxide (see p. 5) to the salt solution. A little sodium perborate may be used instead of the hydrogen peroxide.

VASELINE

Stains from vaseline are usually merely greasy in nature and can be removed readily with one of the following solvents:

1. **Turpentine.**—Sponge fresh stains with this agent (see p. 6). Old stains, even those which have been washed and ironed, usually can be removed by soaking in turpentine.

2. **Absorbents and solvents.**—See "Grease and oils," methods 2 and 3, page 16.

WALNUT (BLACK)

The persistence of stains from the husks of black walnuts is probably due to their content of tannin, which most fibers absorb or combine with very readily. It is possible that the tannin acts as a fixing agent, holding the coloring matter of the husks firmly to the fiber. Fresh stains, which are still moist, usually can be removed, provided the material is strong enough to stand the treatment, but old stains or stains on delicate fabrics in many cases can not be removed. The following reagents are satisfactory in some cases:

1. **Concentrated soap solution.**—Use a half-inch cube of laundry soap to a cup of water, and boil the stained material in this solution. The treatment is successful only with fresh stains on cotton or linen. In the case of week-old stains, a gray color persists which can sometimes be removed by Javelle water (see method 2).

2. **Javelle water.**—Dilute the Javelle water (see p. 4) with an equal volume of hot water. Soak the stained place for one and one-half hours in this solution, then rinse thoroughly, treat with dilute oxalic acid, and rinse again. This is effective in removing a week-old stain and the fibers of the material are not seriously injured. Soaking the stain in Javelle water of full strength, however, rots the material. Do not use Javelle water on silk or wool.

WATER SPOTS

Some silks and wool are spotted by water (see p. 7). This probably dissolves a part of the finishing or weighting substances, and, when the water evaporates, they are deposited irregularly or in rings. A satisfactory method for removing such spots is to dampen the entire material evenly and press it while still damp. This may be done either by sponging the material carefully with clean water or by shaking it in the steam from a briskly boiling teakettle until it is thoroughly damp. Another method is to dip the garment in an organic solvent (see p. 3). Scratching with the finger nail or a stiff brush is sometimes sufficient.

WHITE SAUCES, CREAM SOUPS, GRUEL

These usually consist chiefly of milk and butter, thickened with flour. Flavorings, vegetables, and other added materials do not as a rule effect the character of the stain. The starch and gluten of the flour make it particularly hard to remove such stains from materials that can not be washed. Use one of the following agents for treating these stains:

1. **Soap and water.**—If the material is washable, soap and water is generally sufficient.

2. **Hot water.**—Sponge the stains with hot water (see p. 6). Follow this by a grease solvent when necessary (see p. 15).

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U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1475

SOIL PRODUCTIVITY AS AFFECTED BY CROP ROTATION

1862 1889

THE NATION will have to depend upon the cultivation of the soil for about one-third of its combined wheat, corn, and oats produce; upon crop rotation for another third; and upon the use of manures and commercial fertilizers for the other third.

Crop rotation is nearly as effective as farm manure and complete commercial fertilizers in maintaining and increasing soil productivity, as based on experimental yields of wheat, corn, and oats, taken collectively.

When rotation and the use of fertilizers are practiced together the one practice adds to the benefits of the other.

The relative effectiveness of rotation, as compared with fertilizers, on soils supplied with lime is practically 20 per cent higher than on acid soils.

On soils long under cultivation highest yields are possible only when rotation and the use of fertilizers are practiced together.

In rotation of crops a farmer has at his command, ordinarily without any monetary cost to him, a means whereby he can materially increase the output of his land and reduce acre costs.

A proper rotation is the basis of intensive farming and of profitable land utilization; it provides an effective means for meeting the problem of food production; it permits of farming with livestock; it provides rest for the land, in that leguminous and other renovating crops are alternated with those of an exhausting nature; it permits of clean cultivation and weed control; and it creates other productive-soil conditions.

Crop rotation is the beginning of organized or business farming.

Washington, D. C. **Issued May, 1926**

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SOIL PRODUCTIVITY AS AFFECTED BY CROP ROTATION

By WILBERT W. WEIR, *Associate Soil Technologist, Bureau of Soils*

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FOUR ROTATION FACTS

A STUDY of the long-continued soil-fertility experiments of this country and of England, made by the Department of Agriculture,[1] has brought out the following important facts about crop rotation in its relation to soil productivity, as determined by the soil conditions under which these experiments are conducted:

(1) In general, crop rotation has been found to be practically 95 per cent as effective as farm manure and complete commercial fertilizers in maintaining the yields of wheat, corn, and oats, and about 90 per cent as effective as these fertilizers in increasing the yields of these three major crops.

(2) The beneficial effects of crop rotation do not impair the benefits derived from the use of fertilizers; so that when these two farm practices are combined the one practice adds to the benefits of the other.

(3) When compared with the effectiveness of manure and commercial fertilizers, the relative value of crop rotation is practically 20 per cent higher on soils sufficiently supplied with lime than on soils that are acid.

(4) On soils long under cultivation the highest yields are possible only when the use of manure or commercial fertilizers and rotation of crops are conjoined or practiced together.

These facts are shown graphically in Figure 1.

EXPLANATION OF TERMS

In order to make clear the rotation facts on which this bulletin is based, explanation is here given of a few of the terms used.

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[1] A Study of the Value of Crop Rotation in Relation to Soil Productivity, United States Department of Agriculture, Bulletin No. 1377.

ROTATION OF CROPS

By crop rotation is meant, in general, the growing of different kinds of crops in recurring succession on the same land. A rotation that is best suited to the conditions of a soil and to the characteristics of the crops grown, and from which a farmer may realize maximum benefits, may be called a proper rotation. In more specific terms, a proper rotation may be defined as a system of cropping in which the right combination of intertilled, small-grain, and grass or leguminous crops is grown in the right order and in recurring succession on a given field, or on the same land.

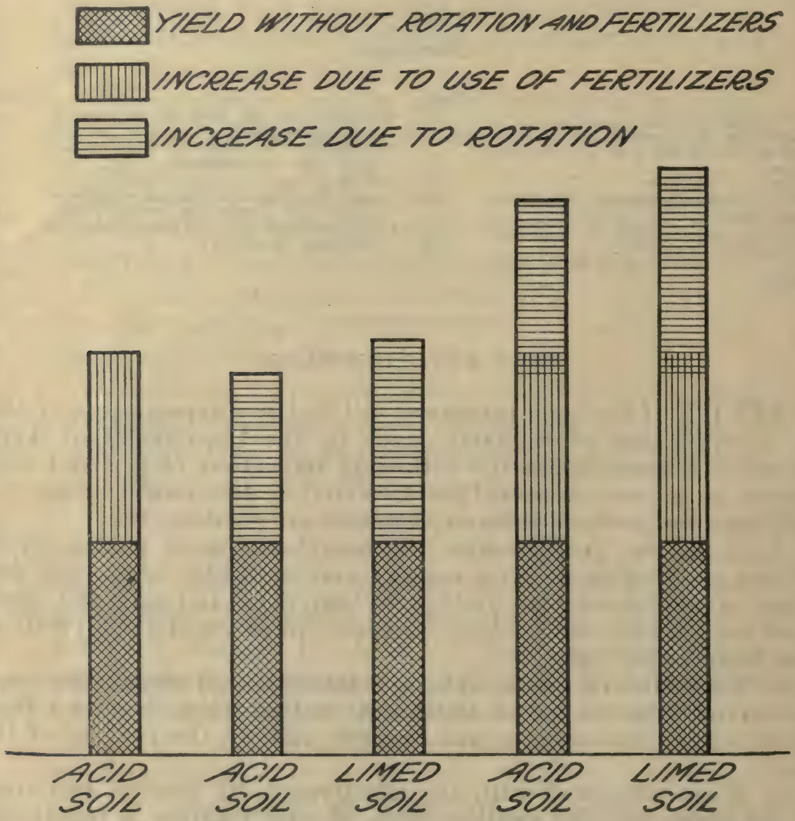

FIG. 1.—Chart showing the importance of crop rotation in relation to soil productivity, as based on the average yields of wheat, corn, and oats obtained in long-continued fertility experiments. The bars represent relative acre yields. The average increase effected when rotation and the use of fertilizers are conjoined does not quite equal the sum of their separate increases, as indicated by the right-angle crosshatching in each of the last two bars

Rotations may also be classed as fixed and flexible. A fixed rotation may be defined as a system of cropping in which the different crops recur at regular intervals and which occupies a fixed number of years. A flexible rotation, on the other hand, may be defined as a cropping system in which intertilled, small-grain, and grass or leguminous crops are grown in the order named, but in which the specific crops may be varied or changed, and in which the number of years is not fixed. The following cropping plans illustrate fixed and flexible rotations. (See also figs. 2 and 4.)

A. FIXED, FOUR-YEAR ROTATION

First year, corn (one year).
Second year, oats (one year).
Third year, wheat (one year).
Fourth year, clover (one year).

B. FLEXIBLE ROTATION

Potatoes or corn (one year).
Barley or wheat (one year).
Soybeans or a combination of clover, timothy, and redtop (one or two years).

Because of changed conditions, rotation B may be changed to the following flexible system:

Corn or corn and potatoes (one year).
Oats or barley (one or two years).
Clover (hay or pasture, one year).
or
Corn (one year).
Wheat or oats (one or two years).
Clover (hay or pasture, one year).
Pasture (one year).

The cropping systems on which the foregoing rotation facts are based are all fixed rotations. At Rothamsted, England, it is a four-course system consisting of rutabagas, barley, clover, and wheat; at Columbia, Mo., four different fixed rotations are included in the experiments; at Wooster, Ohio, it is a five-year rotation of corn, oats, wheat, clover, and timothy; and at Urbana, Ill., a three-year system of corn, oats, and clover is used.

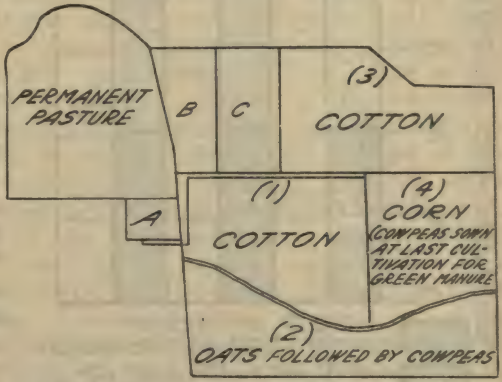

FIG. 2.—A farm layout illustrating a fixed 4-year rotation of cotton, oats, cotton, and corn, occupying the greater part of a southern farm. A. Farm buildings, garden, etc.; B and C, sweet potatoes, peanuts, or other crops

Number of years covered by experiments.—The Rothamsted results which were included in the study of the value of rotation cover a period of 72 years; the Missouri results include a period of 30 years; the Ohio data represented 25 years; and the results selected from the Illinois experiments cover a period of 14 years.

COMPLETE COMMERCIAL FERTILIZER

A complete commercial fertilizer is one which carries all three of the major nutrient elements—nitrogen, phosphorus, and potassium. In the long-time experiments referred to, rotation values were compared with the effects of complete fertilizers, because these fertilizers were found to be more consistently effective in maintaining and increasing soil productivity than those commercial fertilizers in which one or two of the major fertilizing constituents are lacking.

SOIL PRODUCTIVITY

Soil productivity or soil fertility may be defined as the inherent power of a soil for producing good or large yields. The producing power of a soil, whether high or low, is measured or determined only by the character of plant growth or by crop yields.

PRACTICAL INTERPRETATION OF ROTATION FACTS

It is to be observed that the bottom of each bar in Figure 1 represents the average "yield without rotation and fertilizers." This yield has been determined by the tests in which a crop is grown continuously on the same land without any manure or commercial fertilizer. This part of each bar represents, therefore, the yield credited to cultivation of the soil, which includes the preparation of the seed bed and any subsequent tillage or intertillage to kill weeds or to conserve soil moisture. Thus three farm practices are represented in Figure 1—cultivation of the soil, the use of fertilizers, and rotation of crops.

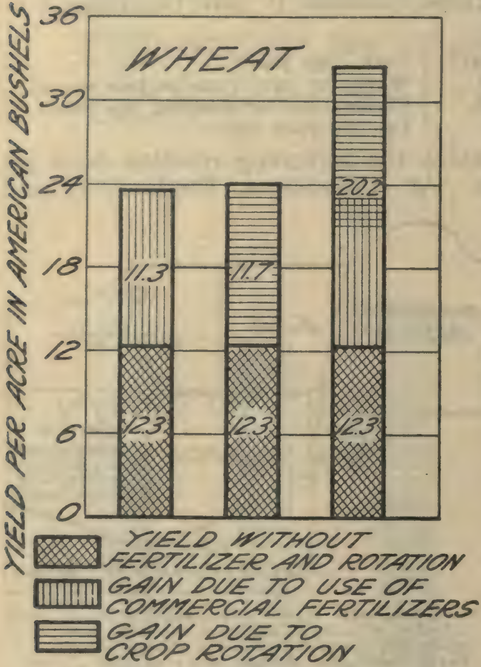

FIG. 3.—Chart illustrating the results obtained with complete commercial fertilizers and rotation on wheat at Rothamsted, England; showing the average yield obtained from cultivation alone, the increase effected by the use of fertilizer or crop rotation when practiced separately, and the increase effected when the use of fertilizer and rotation are conjoined. The increase effected by rotation and the use of fertilizers combined is 2.8 bushels less than the sum of their separate increases, as indicated by the right-angle crosshatching in the third bar

Illustrating the foregoing rotation facts in this manner gives a clearer idea of the comparative and relative values of rotation, and helps to bring out and to emphasize other relations, three in particular: (1) Crop rotation without the use of any manure or commercial fertilizer is nearly as efficient in effecting crop increases as the use of fertilizers without rotation; in other words, the average benefits of rotation are nearly equal to the benefits derived from fertilizers when they are applied to crops grown continuously on the same land; (2) when rotation of crops and the use of fertilizers are conjoined or practiced together, the total increase effected is nearly equal to the sum of their separate increases; (3) from the point of view of soil-management practices, the average total produce per acre of wheat, corn, and oats obtained in these experiments may be divided into three almost equal parts, about one-third being credited to the cultivation of the soil, almost a third to the use of fertilizers and lime, and a third portion to rotation (see the last bar in figs. 1 and 3).

These experimental results throw new light upon the problems of our future food supply and of a permanent national agriculture. It would seem that we shall have to depend upon the cultivation of the soil for at least a third of our wheat, corn, and oats produce, taken collectively; upon the use of soil-improvement materials, such as manure, commercial fertilizers, lime, and green manure, for another third; and upon rotation of crops for the other third. Just as the alternation of crops has played a large part in the improvement of husbandry in the leading nations of the world, particularly during the last half of the eighteenth century and since, so crop rotation in its improved forms is destined to become one of three outstanding factors in the providing of food for our future millions of population.

AIM OF THIS BULLETIN

The purposes of the discussion which follows are to emphasize the value of crop rotation in farming economy and to stress the principles of rotation in their relation to the maintenance of soil productivity and to soil improvement.

A NATIONAL ROTATION NOT POSSIBLE

According to Government statistics, cotton, corn, wheat, oats, and hay are to be regarded as the five major crops grown in the United States, each occupying more than 30,000,000 acres on American farms.[2] The fact that these five crops occupy 87.5 per cent of the total crop area of the country suggests, in theory, a five-course national rotation. But, practically, it is out of the question to consider any kind of rotation that would be suited to all sections of the United States, because the country, being so large, has such wide differences in climatic and other agricultural conditions. However, a study of the distribution of the important crops grown in the agricultural regions of the United States, within the several States and within smaller areas or districts, will show that flexible rotations are practicable in most sections or localities or on most farms. Possible exceptions are on specialized, one-crop farms and in certain dry-land farming sections where, because of scant rainfall, a change from a one-crop system, as from wheat alternating with fallow, is practically impossible or economically hazardous.

ROTATION PRINCIPLES HAVE UNIVERSAL APPLICATION

It is plain that in a bulletin treating of a subject such as this it is not only impracticable but impossible to hinge the discussion on a rotation type, as it is possible in a discussion of a particular breed of livestock or of a variety of corn, to present a standard by type description. But though rotations in different sections, in a given locality, or even on a single farm may differ, because of the manifold circumstances that must be taken into consideration, the principles of crop rotation must be conceded to have general application.

When the principles governing proper rotations are understood by a farmer, he is in a position to think through his cropping problems; and, being guided by principles, he is better able to establish on his fields systems of cropping that will mean higher and more permanent yields produced at lower acre cost.

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[2] W. J. Spillman, Distribution of types of farming in the United States, Department of Agriculture Farmers' Bulletin 1289.

FIXED v. FLEXIBLE CROPPING SYSTEMS

Attention has been called to the fact that, in each of the experiments on which the foregoing facts about the value of rotation are based, the experimental plans are rigid or fixed, there being no modification in the rotation and but little or no change in the fertilizers used. In long-continued fertility experiments, fixity of plans is generally accepted as necessary; but, in practical experience, the farmer usually adopts more or less flexible cropping plans, in that he may alter or even change his rotation or rotations, if necessary, or he may vary the fertilizer treatment in order best to meet the soil and crop requirements, or he may lime his soils only when conditions indicate the necessity for liming. In this manner the maintenance of soil productivity may be accomplished most effectively, as may be observed by studying the soil-management methods practiced by leading farmers, particularly those in the older agricultural sections. It is this idea of elasticity in the cropping system that has given rise to the term "flexible rotation," already defined in a preceding paragraph.

It is not possible to know with any degree of certainty what the average relative value of rotation would have been if, in the experiments previously mentioned, the cropping plans had been given sufficient elasticity to provide or create best conditions for all the crops considered. That flexibility or breaking of the rigidity of the experimental plans would have resulted in higher average yields seems quite certain, since the high average yields obtained by leading farmers carry considerable significance.

FACTORS DETERMINING ROTATIONS

In rational farming, factors like soil type, kind of crop, lay of the land, and economic conditions compel variations in the use of soil-improvement materials and in rotations on probably the majority of farms. Because of the lack of uniformity in conditions on individual farms, taking into consideration all farms, there are only a comparatively few farms having conditions favorable to permit of each being divided into a certain number of fields to accommodate a single, fixed rotation. Uniformity of soil, as regards kind or producing power, is the unusual rather than the average condition that prevails. A rotation best suited to a field of low-producing sandy soil is hardly suited to a highly productive silt loam. A hillside field subject to soil washing calls for a different management as regards rotation than a field on a flat area, and so on. It is often easier to vary a rotation to suit the fields than to alter the fields to suit a rotation. (Fig. 4.)

The primary question that confronts a farmer who farms more or less with livestock does not concern rotation so much as it does the acreage of crops necessary to meet his feeding requirements. On the other hand, the truck grower is concerned primarily with the question of crops in relation to market conditions. In either case rotation is a means to an end, and the cropping problem resolves itself into two parts: (1) The growing of the desired crops in a manner, or in different rotations, best suited to the soil and crop conditions; and (2) the dovetailing, as it were, of the different rotations so as to enable the farmer to realize annually the required acreage of each crop he desires.

Local conditions may arise which will make flexibility of rotations highly desirable, such as insect pests, crop diseases, or weeds. In Tennessee, for example, a simple means recommended for reducing army-worm injury was to change a common fixed rotation of corn, wheat, and meadow to corn and cowpeas for the first year, wheat for the second, and meadow for the third year. In order to combat some obnoxious weed a farmer may introduce into the rotation on a certain field an additional intertilled crop.

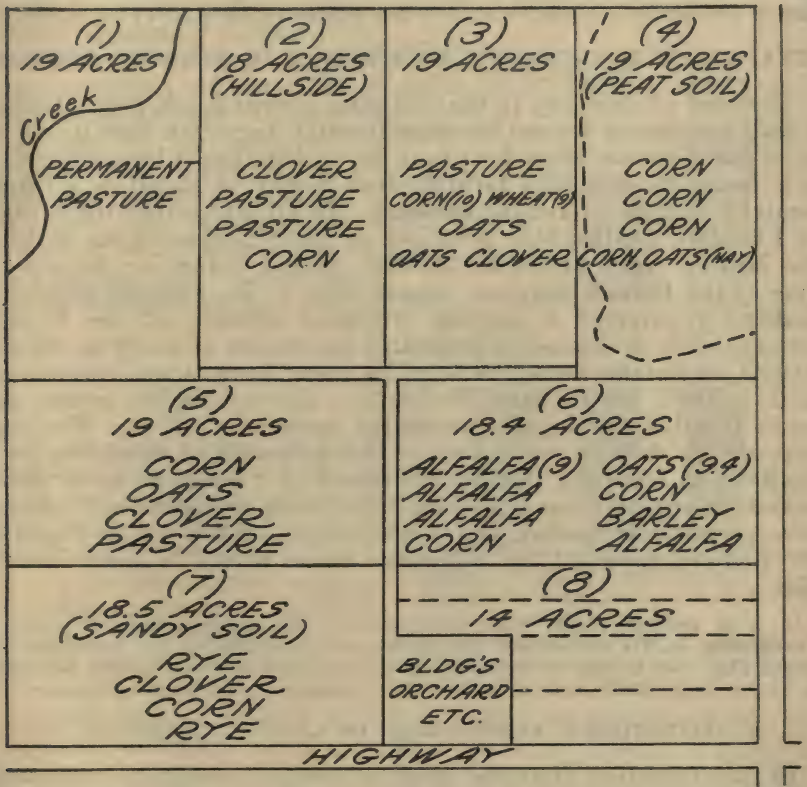

FIG. 4.—Diagram of a 160-acre farm, illustrating soil conditions which necessitate the application of the principle of flexibility in cropping. Field 2 is a hillside, field 4 consists mostly of peat soil (drained), field 7 is sandy soil, field 6 has soil conditions favorable to alfalfa, and field 8 is devoted to a 4-year rotation of clover, cabbage, tomatoes, and barley or wheat. Each year the farmer desires to grow about 38 acres of corn, 32 acres of hay, from 30 to 37 acres of small grains, 18 or 19 acres of pasture in rotation, and 3.5 acres each of cabbage and tomatoes

Changes in economic or market conditions may compel rotation changes. England affords a good example of the effect of changed economic conditions on a cropping system.[3] For more than a century the celebrated Norfolk four-course rotation of roots (turnips or rutabagas), barley, clover, and wheat was regarded as the standard rotation in British agriculture; but now it is being found (by the Northumbrian farmers in particular) that better results can be obtained when, in the Norfolk plan, the hay crop is left two years instead of one, thus making it a five-course rotation.

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[3] Rew and Russell. Possibilities of British Agriculture, in Rothamsted Memoirs, Vol. XI, 1920–22.

In planning rotations the farmer should be mindful of the possibility that changes in rotation may become desirable or necessary. Confronted with such possibilities he may come to realize that, under like conditions, a cropping system which will permit of easy alteration is preferable to one that does not possess this quality of elasticity.

FLEXIBILITY IN CROPPING, A PRINCIPLE IN FARMING ECONOMY

The idea of elasticity in the cropping system is not new. In fact, it long ago passed beyond the experimental stage; nor does it now require any demonstration for proof, for so long has it been recognized as a factor in successful farming that it may be stated as a fundamental principle in farming economy. In all probability the farmers of Flanders applied this principle in their husbandry as early as the Middle Ages (476–1300 A. D.), if not before or during the time of the Roman Empire. About 1600 A. D., English writers on husbandry referred to certain cropping schemes of the Flemish farmers, such as change of crops and adaptation of crops to soil conditions, as having been practiced by them from times immemorial. And, in 1645, Sir Richard Weston,[4] on discovering the secrets that made possible the highly successful husbandry of the Flemings, gave such a definite expression of this principle of flexibility or of elasticity in cropping that his statement of it needs no modification to make it applicable as a guiding principle in successful soil management even in our modern and scientific age. While yet in Flanders, Sir Richard recorded the following words in his "Legacy" to his son:

> It is a certain thing, that the chiefest and fundamentallest point in Husbandrie, is, To understand the nature and condition of the Land that one would Till; and to sow it with such Seed as it will produce, either Naturally, or by Art, that which may turn to a Man's greatest profit and advantage.

ROTATION v. FERTILIZERS IN LAND UTILIZATION

In the utilization of arable lands, economists recognize three stages of development. The first stage is a period in which virgin, productive soils are usually subjected to exhaustive cropping, and in which little or no thought is given to proper cultivation or to returning anything to the land with a view to prolonging its productivity. Very often this stage is characterized by the growing of one major crop almost continuously on the same land, such as tobacco during the early colonial days, particularly in Maryland and Virginia, and later on, in other sections, wheat or corn. During this first period the value of manure is hardly appreciated, crop rotation is rarely practiced, and, as one observer has stated it with particular reference to colonial farming, new land is constantly brought into cultivation as soon as that which is already under the plow refuses to produce anything that is worth harvesting.

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[4] Sir Richard Weston, The husbandrie of Brabant and Flanders, in Hartlibs's Husbandrie, 1654, p. 5.

The second stage is a period in which the farmer realizes that, if he is to succeed in growing any crops at all that would give him sufficient encouragement for his labors, he would have to cultivate his land more carefully, modify his cropping system and utilize any farm manure produced for the good of the land, all with a view to preserving, in a manner, the producing qualities of his soils. This period may be called the extensive stage.

The third stage is a period in which the farmer gives much thought to cultivation and to drainage, if necessary, to rotation of crops, and to the use of soil-improvement materials. This is the intensive stage, which ultimately results in a higher yield per acre, but a smaller yield per man. With the average farmer, the sign of his approach to the third stage is the increased attention he gives to those soil-management practices which enable him to produce high yields at the lowest possible cost per acre.

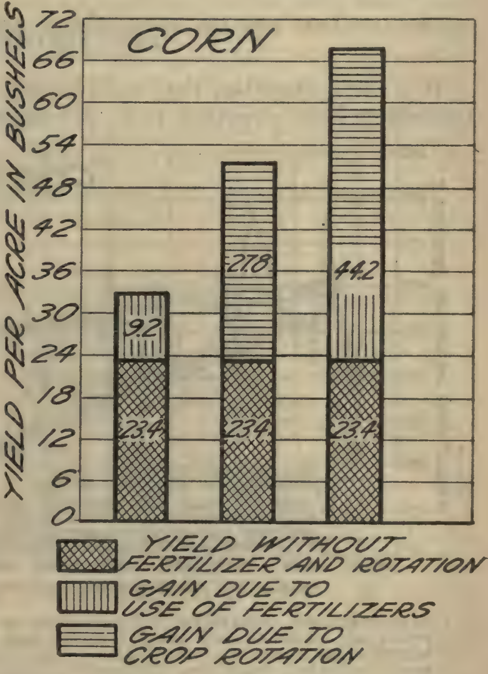

Fig. 5.—Chart visualizing the experimental results obtained in growing corn on fertile prairie soil at Urbana, Ill., showing the average yield obtained from cultivation alone, the increase effected by the use of fertilizer or crop rotation when practiced separately, and the increase obtained when the use of fertilizer and rotation are conjoined

ROTATION AS GOOD AS FERTILIZER

In the light of the study that has been made of the value of crop rotation, it may well be assumed that on naturally productive soils a proper rotation may for many years prove more effective in maintaining yields than farm manure or single, mixed, or even complete commercial fertilizers. In time, however, the manure or commercial fertilizers may give more and more positive results until they approach the effectiveness of rotation, as the experiments with corn at Urbana, Ill., seem to show.

In the experiments at Urbana the soil treatment consists in the use of pulverized limestone, farm manure, and phosphate fertilizers (bone meal and rock phosphate); and the rotation consists of corn, oats, and clover. (See fig. 5.)

Three important points are brought out in the chart in Figure 5: (1) The average yield of corn obtained without fertilizers and rotation on this particular prairie soil in Illinois is 23.4 bushels per acre (equivalent in bushels of shelled corn); (2) the gain effected by rotation alone is practically three times that obtained from the use of fertilizers and lime; and (3) the total increase effected by conjoining rotation and the use of fertilizers is 7.2 bushels greater than the sum of their separate increases.

It is a well-known fact that, when an arable soil is well supplied with organic matter, nitrogen, and the necessary mineral elements, it shows but little or no response to fertilizer treatments. On the other hand, a particular crop may be grown successfully on the same land only when it is introduced into a rotation. This is particularly true in case the crop is attacked by certain insect pests or crop diseases, in which case the change of crops aids in the control of such insects or diseases or prevents their development.

ROTATION AND USE OF FERTILIZERS COMPANION PRACTICES IN PERMANENT AGRICULTURE

It is to be observed that cultivation of the soil in some manner is a necessary farm practice in all the stages of development in land utilization, and that as virgin and arable lands are kept longer and longer under cultivation, crop rotation and the use of fertilizers become companion practices to which a farmer must give more and more attention if he desires to retain ownership of his farm lands. History shows that sooner or later one-crop farming or any form of continuous exhaustive cropping brings the best of virgin soils to a point where the use of manure or some form of commercial fertilizer, or a combination of both, becomes necessary in order to make them produce profitable yields, and also to a point where the highest yields and permanent productivity can not be attained without conjoining rotation of crops and the use of fertilizers with the oldest of all farm practices, the cultivation of the soil. The results of the long-continued fertility tests obtained in this country and in Europe prove this point experimentally. (Fig. 6.)

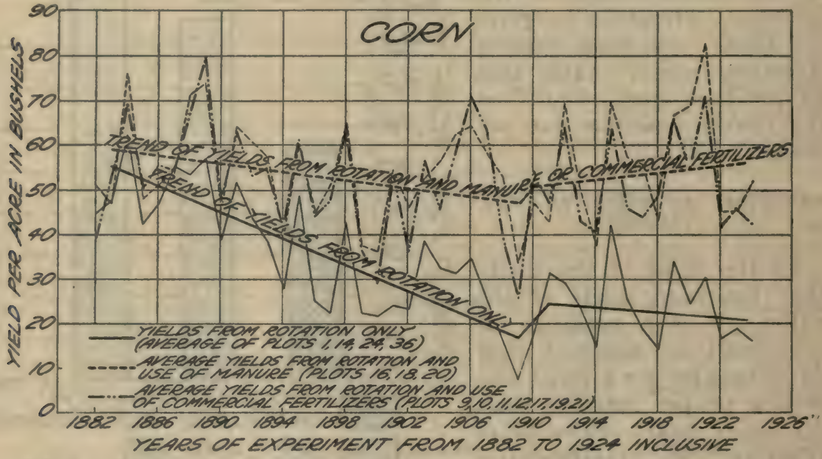

FIG. 6.—Diagram illustrating the fact that, in permanent soil productivity, highest yields are possible only when rotation and the use of fertilizers are practiced together, as shown by the yields of corn obtained in 43 years of experimental work at State College, Pa. Note that, under rotation alone, the producing power of the soil has gradually declined, as indicated by the trend of the average yields obtained from rotation; and that, under the conjoint effects of rotation and the use of manure or commercial fertilizers, soil productivity has not suffered decline as in case of rotation alone. (From published and unpublished data of the Pennsylvania Agricultural Experiment Station)

ROTATION NOT AN ITEM OF EXPENSE IN COST ACCOUNTING

In farm cost accounting, cultivation of the soil is represented in the cost columns by different expense items, such as plowing, harrowing, and cultivation; so that the tillage necessary in the preparation of the seed bed and any subsequent cultivation or intertillage are more or less expensive farm operations. Fertilizers also appear as an item of expense, including initial cost of the materials, and other costs such as interest charges and costs involved in getting the fertilizers applied. Many expenditures on one crop help to benefit succeeding crops. The cultivation of corn leaves the land weed free for the small-grain crop following, fertilizer applied to wheat helps the growth of the grass as well, while the roots and organic matter left by the grass crop, plus accumulated nitrogen if a legume is used, leave material for the corn to feed on. To be entirely adequate, any system of cost accounts should show credits to each crop for its contribution to the next one. Unfortunately these contributions of one crop to another are of such a character that they can not be measured, hence can not be shown in cost accounts, but they are very real for all that.

Rotation of crops, on the other hand, does not appear as an item of expense in any farm cost-accounting system. This means that whatever time or energy a farmer expends in planning a rotation, that is, in determining a sequence of crops which will enable each crop to derive the maximum benefit from preceding crops and give the greatest benefit to subsequent crops, and in getting the rotation established on his farm, is counted as an expression of his managerial ability, for which he receives reward in the form of managerial income, if through good management he succeeds in realizing net profits. Thus in rotation of crops a farmer has at his command, ordinarily without any monetary cost to him, a means whereby he can materially increase the output of his land and reduce acre costs. It is a farm practice which may prove equally as effective or even more so than the use of manure or commercial fertilizers in maintaining and increasing the productivity of his soils. This important fact regarding the value of rotation in relation to production costs is worthy of the serious consideration of every American farmer.

INTERACTION OF ROTATION, CULTIVATION, AND SOIL FERTILIZATION

The importance of cultivation, rotation, and of the use of fertilizers in permanent soil productivity must be recognized, if the results of long-continued fertility experiments carry any significance. It has been shown that each of these farm practices has a separate value in relation to productivity. It is logical to believe that cultivation aids both rotation and fertilization, that rotation aids in rendering fertilizers more effective, and that fertilizers increase the value of rotation. That rotation and the use of fertilizers, when practiced together, may interact to the extent that their conjoint effects, as measured in terms of crop increases, may be greater than the sum of their separate effects is clearly shown in the experiments with corn at Urbana, Ill. (see fig. 5), and in the experiments with commercial fertilizer on both wheat and corn at Wooster, Ohio (see figs. 7 and 8).

INTERRELATION OF ROTATION, CULTIVATION, AND FERTILIZATION IN SOIL IMPROVEMENT AND PERMANENT PRODUCTIVITY

In a previous paragraph reference is made to cultivation of the soil, rotation of crops, and fertilization as the outstanding farm practices on which a permanent national agriculture must rest. The experimental results from which this conclusion has been drawn seem to show also that these three farm practices will have almost equal values when the total produce of wheat, corn, and oats, taken collectively, is considered.

Assuming a one-crop system on a given farm, in a community, or for the whole country, the average relative yield of corn, wheat, and oats may be just about doubled by introducing rotation, and if the land has been long under cultivation the further introduction of the use of necessary fertilizers may give an additional increase about equal to that obtained by the introduction of rotation.

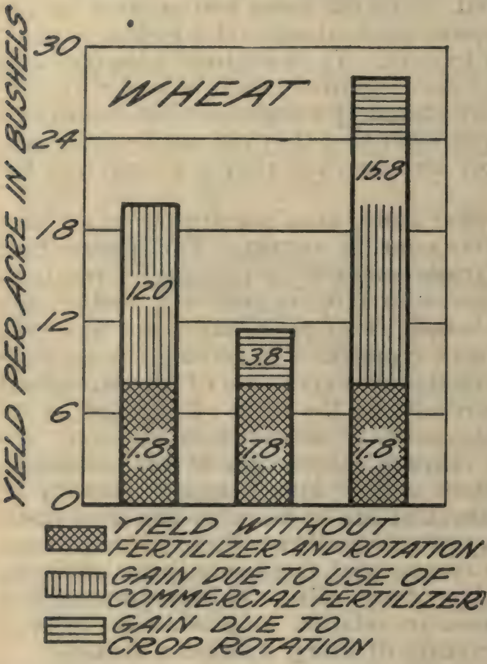

FIG. 7.—Chart showing the results obtained with commercial fertilizer and rotation on wheat at Wooster, Ohio, in which the total increase effected by conjoining rotation and the use of fertilizers is greater than the sum of their separate increases

If conditions were such as to make possible so simple a productivity program, the food problem of the Nation would not prove a serious one for many years to come. The actual conditions, however, call for an entirely different interpretation or application of the facts visualized in Figure 1.

Cultivation of the soil is generally practiced in some manner. Rotation of some sort is practiced by most farmers, even though it may consist in merely a change in crops without any definite plan or any degree of regularity. Farm manure is usually disposed of for the good of the land, and commercial fertilizers are coming more and more into use, either specially in single or incomplete forms to correct certain soil deficiencies or to meet the requirements of special crops, or generally in mixed or complete forms.

Taking into consideration the whole country or any particular section of it, the only way in which cultivation may operate as a factor in maintaining yields or in which it may become effective in increasing soil productivity is by giving attention to or by improving tillage methods or practices. Results along improvement lines can be realized only to the extent that each farmer masters the principles of tillage and studies his soils, crops, and machinery so that he may be able to make the proper application of the tillage principles to the conditions on his farm through the means at his command.

Farm manure and commercial fertilizers seem to be regarded as possessing the greatest possibilities with reference to maintaining soil productivity and in effecting increases in crop yields. (Figs. 9 and 10.) Judging from the experiences of farmers who have used such materials as dung, seaweed ashes, wood ashes, street refuse, and certain kinds of marl during pre-Roman and Roman times, and from the profound effects that manufactured or commercial fertilizers have had, since 1840, on the agriculture of the leading nations of the world, the basis for the recognition of large possibilities in the use of manure and commercial fertilizers is well grounded.

As regards rotation, its full benefits very probably can not be realized by adhering to fixed rotations, but rather by applying the principle of flexibility in the cropping system. Just as it is possible for a farmer to increase the effectiveness of cultivation and of the use of fertilizers, so it is possible for him to increase the efficiency of rotations as well, by giving more attention to systematic alternation of crops, particularly to proper rotations. (See definition, p. 2.) Furthermore, by means of rotation the farmer is afforded opportunities to improve his soils in ways that do not necessarily depend upon the use of manure or commercial fertilizers, ways which, at the same time, will create soil conditions that may increase the effectiveness of applied fertilizers.

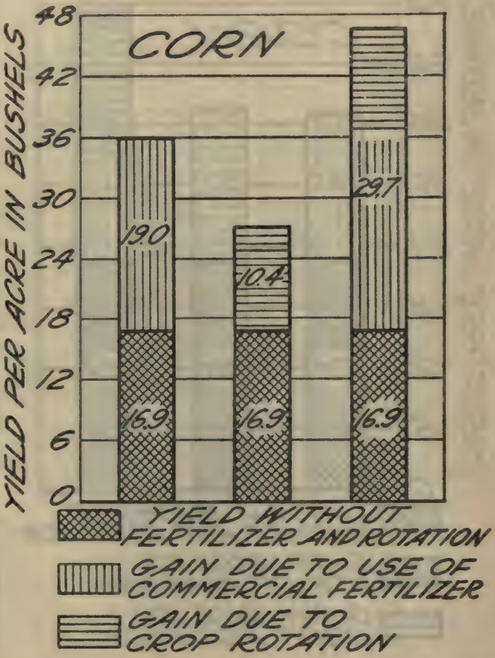

FIG. 8.—Chart showing the results obtained with commercial fertilizers and rotation on corn at Wooster, Ohio, in which the total increase effected by conjoining rotation and the use of fertilizers is somewhat greater than the sum of their separate increases

In order that a farmer may accomplish the most by his efforts, either alone or in cooperation with his county agent or State college of agriculture, it is essential that he understand the principles which govern a proper rotation and be guided thereby.

PRINCIPLES OF PROPER ROTATION

There are three principles which govern a proper rotation. The first one concerns soil conditions in general, as effecting soil productivity: the second has to do with the interactive effects of the characteristics of any particular soil on crop yields; and the third concerns the effects of crops on those which follow. These principles may be stated, respectively, as follows:

(1) Soil conditions most favorable to productivity can best be maintained on arable lands when intertilled, small-grain, and grass or leguminous crops are grown in the order named, and in recurring succession on a given area of land.

(2) The conditions or characteristics of a particular soil determine in a large measure what crops are best adapted to that soil.

(3) The growing of one kind of crop affects to a greater or less degree the growth of another crop which follows.

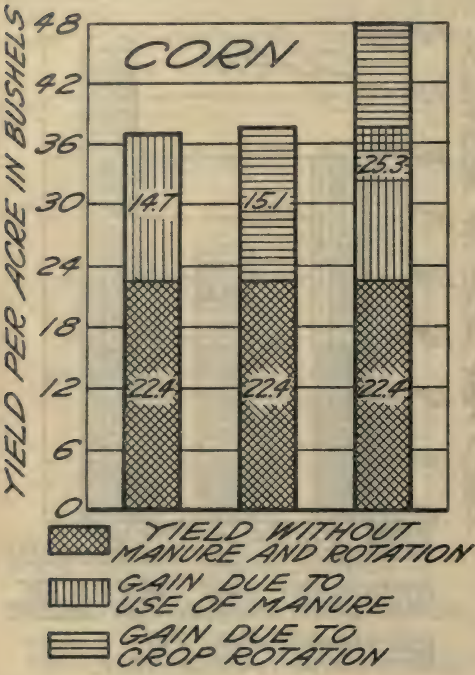

FIG. 9.—Chart illustrating the results obtained with manure and rotation on corn at Columbia, Mo., showing the average yield obtained from cultivation alone, the increase effected by the use of manure or rotation when practiced separately, and the increase effected when the use of manure is added to rotation. Note that in this experiment the gain of 25.3 bushels, as is shown in the third bar, is not fully additive, being less by 4.5 bushels than the sum of the separate gains obtained from the use of manure and rotation

These principles may be transposed into rules of action, as follows: (1) Maintain those soil conditions essential to productivity that are made possible only by alternation of crops; (2) grow those crops which are best adapted to the characteristics of any particular soil; and (3) grow crops in the order that each may have a favorable effect on the one which follows.

ESTABLISHING PRODUCTIVE-SOIL CONDITIONS BY ALTERNATION OF CROPS

The starting point in establishing proper rotations, in harmony with the first of the principles named above, is to grow an intertilled crop, a small-grain crop, and a grass or leguminous crop in the order as named. The selection of these three classes of crops and the order of their cropping have grown out of the practical experiences of farmers of all ages, as indicated by records which cover a period of more than 3,000 years. Because of the fact that the experiences out of which has evolved this practice of proper cropping are deeply rooted in human history, it may prove profitable, in order that the importance of this system of cropping may be fully appreciated to-day, to recount briefly four stages in its development.

"Thou shalt let it rest."—When early peoples adopted sedentary habits, cereals became their chief sources of food. In those primitive times it was natural that these crops should be grown almost continuously on the same fields so long as the land would yield remunerative crops. These early peoples soon learned that continued exhaustive cropping resulted in lower and lower yields or crop failure and that resting the land renewed its producing power. This knowledge gave rise to the custom of abandoning the land, at more or less regular intervals, to the natural growth of rough and weedy herbage, which offered scanty food for domestic animals. The oldest record of such a practice is to be found in the Mosaic laws, which were given to the Israelites, for their government on entering the promised land (about 1400 B. C.). In Exodus xxiii, 10 and 11, we find this command:

> And six years thou shalt sow thy land, and shalt gather in the fruits thereof: But the seventh year thou shalt let it rest and lie still; that the poor of thy people may eat; and what they leave the beasts of the field shall eat. In like manner thou shalt deal with thy vineyard, and thy oliveyard.

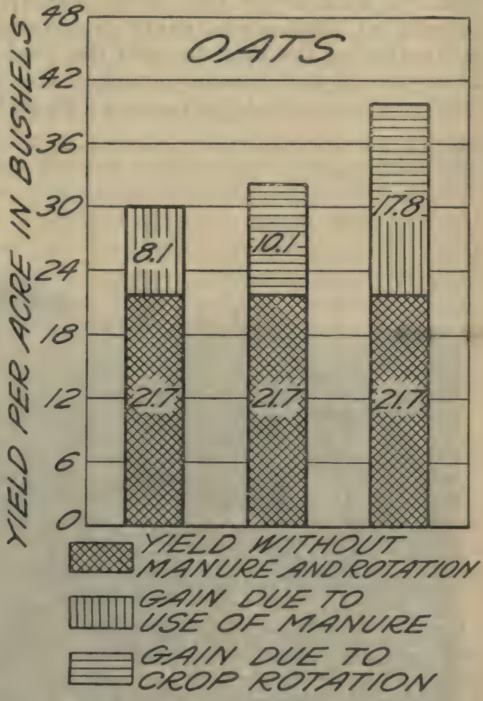

FIG. 10.—Diagram illustrating the results obtained with manure and rotation on oats at Wooster, Ohio, showing the average yield obtained from cultivation alone, the increase effected by the use of manure or rotation when practiced separately, and the increase effected when the use of manure and rotation are practiced together. Note that the total increase of 17.8 bushels shown in the third bar is just about equal to the sum of the increases from manure and rotation

The second or bare-fallow stage.—During the time of the Roman Empire (29 B. C. to 476 A. D.) and in Saxon times (second to eighth century) we meet with the practice of fallowing, which originated from the ancient state of the common field. During this time the village had the control of the land, and husbandry assumed a three-field system, consisting of a winter grain like wheat followed by a spring grain like barley, which in turn was followed by "dead" fallow. This system had two great advantages over the "resting" or "repose" husbandry of pre-Roman days. It enabled the husbandman better to meet the great problem of weeds, and it enabled the farmer, for a time at least, to produce more food per unit of land. This famous triennial cropping scheme of the Romans survived the Dark Ages (476–1300 A. D.) and was reestablished in Europe during the Renaissance; it persisted in England during the eighteenth century in spite of thousands of inclosure acts; it was carried to the New World by the early settlers, and it still lingers even to this day in parts of Europe and the United States.

Third stage, the introduction of clover.—Improvement upon the fallow or repose system of husbandry, attainable by alternating leguminous crops with the cereals, was distinctly recognized by the

Romans more than 2,000 years ago; but this improvement did not make much progress in the field, owing, no doubt, to the rigid adherence to the Roman three-field system. Nevertheless there was one district in western Europe, the light-soil area of Flanders, where the Roman three-field husbandry left no trace. The Flemish farmers had evidently abolished the fallow at a very early date, and from times immemorial had been growing clover and other legumes in rotation with crops like hemp, turnips, and small grains. Here a density of population early demanded not only a more intensive utilization of the land to meet the food problem, but a system of soil management that would permit of the keeping of more livestock and that would establish permanency of soil productivity. (Fig. 11.)

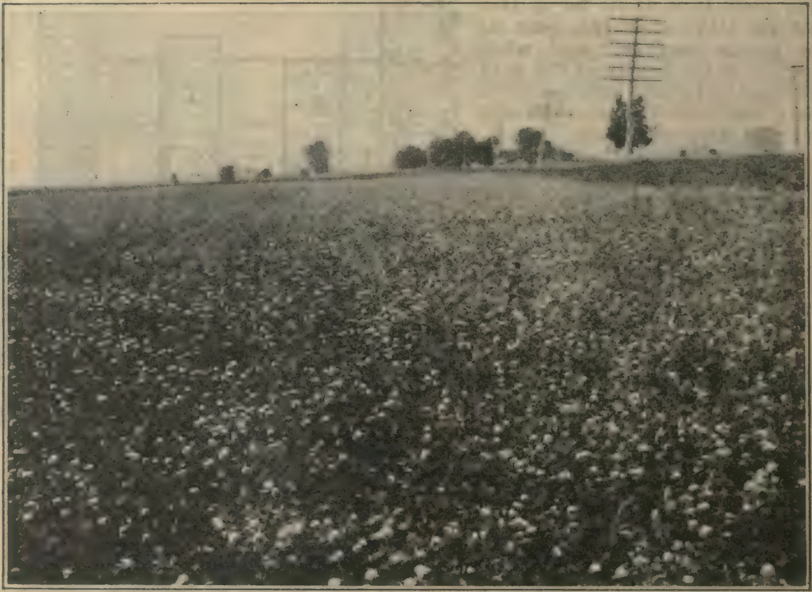

FIG. 11.—Resting the land on good clover. Grass and particularly legumes are the renovating crops in a rotation. The introduction of clover into the rotation was a big step in the improvement of husbandry, and the growth of good grass or legumes is the best evidence of soil productivity

In writing about the clover in Flanders, as he had observed it in 1675, John Worlidge,[5] of England, said of it:

> This Grass hath born the name and is estimated the most principal of Grass, both for the great Improvement it brings by its prodigious Burthen, and by the excellencie of the Grass or Hay for Food for Cattle. * * * It hath also this Property, that after the growing of the Clover-grass * * * it will so frame the Earth, that it will be very fit for Corn again.

From the clover-growing experiences of the Flemish farmers had sprung the following two proverbial sayings, both of which carry ideas worthy of the consideration of the farmers, even in the best-cultivated areas of our country.

> No forage, no cattle; without cattle, no manure; and without manure, no crop.
>
> Without clover no man in Flanders would presume to call himself a farmer.

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[5] John Worlidge, System of Husbandry, England, 1675.

So successful were the Flemish farmers, that as early as during 1600 and a part of the century following, Flanders had become the school of a new husbandry in Europe.

Fourth stage, the introduction of intertillage.—In Flanders, and also in other parts of Europe, all seeds sown in the field were broadcast; so that when the Flemish rotation-with-clover husbandry was attempted in England, for instance, it came into conflict with the strongly intrenched grain-grain-fallow system, and above all, with probably the greatest weed problem in the history of English agriculture. Although the art of hoeing in between rows of plants grown in the garden and in the vineyard had been practiced from the earliest times by the Roman farmers, it had not been carried into the field. Nobody seemed to have thought of the idea of applying garden tillage to the crops grown in the field as a means of meeting the weed problem, which would become the more acute on the abolition of the bare fallow, until Jethro Tull (during the early years of the eighteenth century) introduced into English husbandry, particularly on his own farm, the idea of planting crops in rows to permit of their being intertilled. Because of the fact that turnips was the principal intertilled crop in this new cropping scheme, it was commonly called turnip, horse-hoeing or drill husbandry.

For years Tull's ideas were regarded by nearly all English farmers as speculative innovations, and hence they did not make very much of a general impression upon the agriculture of England until near the close of the eighteenth century, when the famous Norfolk rotation of turnips, barley, clover, and wheat, originally introduced into the county of the same name by Lord Townshend in 1730, became firmly established in English agriculture. Then it was that England, instead of Flanders, became the school of agriculture in western Europe.

The keystone principle of rotation.—The introduction of intertillage into the field gave rise to one of the greatest improvements in agriculture. Its introduction as an improvement over the Flemish husbandry completed the development of a system of cropping which gives full expression of the first principle governing proper rotations: Soil conditions most favorable to productivity can best be maintained on arable lands when intertilled, small-grain, and grass or leguminous crops are grown in the order named, and in recurring succession on a given area of land. When it is remembered that it required more than 33 centuries of farming experience to bring this principle to its full recognition, we can begin to appreciate its keystone importance in the solution of many of the agricultural problems brought into existence largely because of the increasing demands of human society.

The application of this first principle is (1) the basis of intensive farming and of profitable land utilization, (2) it provides an effective means for meeting the problem of food production, (3) it permits of farming with livestock, (4) it provides rest for the land in that leguminous and other replenishing crops are alternated with those of an exhausting nature, (5) it permits of clean cultivation and weed control, and (6) it creates other productive-soil conditions.

General applicability of the first principle.—Much can be written describing the different rotations that are possible in the various sections of the United States, as based on the basic principle of proper rotation which concerns the alternation of intertilled and grass or leguminous crops with small grains. Representatives of these three classes of crops are grown in practically every section of the country, so that this principle may be applied generally. In some sections, as in New England, hay and pasture must necessarily occupy most of the years of the rotation; in other sections, as on the rich prairies of the Corn Belt, two and possibly three crops of corn may be grown in succession on many farms, with clover and small grain; and in the South it would seem that cotton, corn, and legumes will constitute the major crops of the rotations, especially in the southern portion of the Cotton Belt.

Study of soil conditions and characteristics in their relation to crop adaptation.—In the agricultural writings of the ancients, particularly the Romans, we find reference to a very old way of how they used to judge of the productive qualities of virgin lands. They noted the kinds of trees, and the character of their growth, large trees of certain kinds usually indicating a high degree of productivity. This method of judging virgin soils was adhered to for many centuries, and it was generally used during the pioneer days of the settlement of America. On the other hand, lands in humid regions that did not support tree growth were considered unfit for farming. This manner of judging soils may be regarded as an early recognition of the second principle governing proper rotations: The conditions or characteristics of a particular soil determine in a large measure what plants or crops are best adapted to that soil.

The success of the early Flemish farmers was due, in part, to their practical application of this principle. Sir Richard Weston, on visiting Flanders as early as 1645, was thoroughly convinced of the idea that successful husbandry depended largely upon the knowledge a farmer had of the conditions or characteristics of his soils, and upon the extent to which he considered these conditions or characteristics when making the choice of crops he desired to grow. (See quotation on p. 8.) It is the recognition of this principle that has given rise to such terms as "wheat soils," "corn soils," "potato soils," and "tobacco soils"; and to such practical recommendations as the growing of rye on sandy lands, of cowpeas or soy beans instead of alfalfa on soils of medium acidity, of timothy, redtop, and other grasses on heavy soils, and of alfalfa, sweet clover, and red clover on soils sufficiently supplied with lime and other essential constituents.

Because of the interrelationship of soil and crop characteristics, a rotation best suited to a sandy soil may prove a poor one for a heavy clay, and a rotation that proves most profitable on a deep black loam may be a losing proposition on a well-drained peat. On one portion of his land, because of favorable soil characteristics, a farmer may succeed with a rotation containing alfalfa, whereas on another part of the same farm the same rotation may fail because of some unfavorable soil characteristic.

Growing crops in the order that each may affect favorably the one which follows.—The growing of an intertilled crop, a small-grain, and a grass or leguminous crop, in the order named, has come to be recognized as the correct order for these three classes of crops, this practice having been proved by the leading farmers, especially of Europe and America, during the last 200 years. It is well known that the effects of one crop on the other are beneficial when they are grown in the order indicated; but there are some crops which do not affect favorably certain crops which follow them, as is shown, for example, by the experiments at the Rhode Island Agricultural Experiment Station.[6] Pot tests have shown that onions, buckwheat, and alsike clover grown on soil previously occupied by other crops for two or three successive years varied widely in their yields and that the differences in yields did not seem to have been due to the removal of different quantities of nutrient elements by the preceding crops. Field tests with millet, buckwheat, barley, oats, wheat, and rye have given similar results. In commenting on these results the experimenters said:

> The soil acidity was affected differently by the several crops and, generally, the best yields of the onion, a plant which is sensitive to conditions accompanying acidity, followed the crop giving rise to the least acidity. These indications assume added importance because of the observed fact that the effects of the crops on those which follow were much less divergent if the soil acidity was reduced by liming.

Figure 12, taken from Bulletin 190 of the Rhode Island Agricultural Experiment Station, illustrates, relatively, how yields are affected by preceding crops.

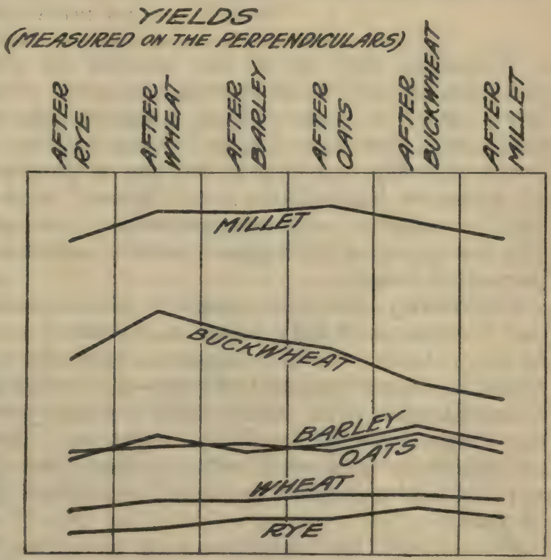

FIG. 12.—Diagram based on relative yields, showing how crops affect the yields of crops which immediately follow. In 1920 these six crops were grown on as many strips running in one direction. In 1921 the same crops were grown in the same field, but in strips crossing the 1920 strips at right angles. It is to be noted that, in this particular experiment, buckwheat gave the highest yield when it followed wheat, and the lowest yield when it followed millet. The yields of barley were best when it was grown after buckwheat and wheat. Oats yielded the poorest after rye, oats, and millet. The yield of rye was best after buckwheat; and the yields of wheat were best when grown after oats and buckwheat

Further work at the Rhode Island station has shown that the yields of corn and oats following corn are better than the yields following mangels.

Other experiment station workers have recognized this third principle of rotation, in its relation to particular crops and under different conditions. For example, at the North Dakota experiment station it has been found that good yields of wheat are obtained after corn, potatoes, oats, rye, barley, flax, and peas; and that the yields are poor after German millet.

The Kansas experiment station has reported that, under irrigation, sugar beets and small grain do best when they are sown after potatoes grown on alfalfa sod, and that corn does not do well when planted after sugar beets. Under similar conditions in the Yellow-stone Valley, Mont., it has been found that sugar beets do best when they follow flax in a six-year rotation of alfalfa (three years), corn, flax, and sugar beets; and that in Nebraska, corn will not do best if planted after sugar beets. Many farmers have also learned by experience that corn yields poorly after beets.

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[6] Rhode Island Agricultural Experiment Station publications: Bulletins 175, 176, 190, and 198.

The foregoing results serve to emphasize the importance of the right combination and sequence of crops in the rotation.

SHORT v. LONG ROTATIONS

Rotations vary as to the number of years which they occupy. Whether or not a short rotation, such as a three-year rotation, is more effective than a long rotation, say a six-year rotation, for example, depends on the following factors: (1) The combination of crops; (2) the order in which the crops are grown; (3) the number of grass or leguminous crops grown in a given period of years; (4) the number of nonleguminous crops grown in succession; and (5) the quantity of organic matter added to the soil during a given period of years.

Ordinarily, the comparative effectiveness of different rotations can be measured only when one, two, or more like crops are grown in the rotations to be compared, and when comparative yields represent the same seasonal effects—the comparative rotation efficiencies being based on the comparable average yields of the like crops, or the crops common to all the rotations. An important factor commonly to be reckoned with is fertilizers—the kind and quantity applied to the crops in common, or applied per acre in a given period of years.

Grass, hay, and legumes may be called the renovating crops of a rotation, because of a combination of several beneficial effects. The growing of such grasses as redtop, timothy, and clover on heavy soils brings about remarkable changes in the workability of such soils, as a result of the organic matter added in the form of profuse and extensive growths of fine roots. Strong taproot grasses, like sweet clover and alfalfa, function not only in puncturing hard and compact subsoils and thereby promoting soil aeration and drainage, but, because of the high nitrogen and low carbohydrate contents of their roots and stubble, they add to the soil readily available nitrogen. The general renovating effects resulting from the growing of the clovers are well known. In fact, this class of legumes has played and is still playing an important rôle in the improvement of the agriculture of the leading nations of the world.

COMMON ERRORS IN ROTATION

Two common mistakes are thoughtlessly made by some farmers, namely, the growing of two or more intertilled crops and of several small-grain crops in succession on the same land. An intertilled crop following a good clover or alfalfa sod is usually excellent, and, because it is so good, the farmer is tempted to grow two or more intertilled crops following the clover or alfalfa crop. Intertillage, or the growing of intertilled crops, has the inevitable effect of causing a most rapid destruction of the soil organic matter. Thus when several intertilled and small-grain crops are grown after a good sod has been turned under, but little or no permanent soil improvement can, in the long run, be accomplished, particularly if little or no recourse is made to outside sources for organic matter and elements of plant food. As a safe rule, two small-grain crops of the same kind or two intertilled crops should be the maximum number of nonleguminous crops that should be grown in succession, since this will take care of practically all cases where it becomes necessary to grow another intertilled crop after an intertilled crop, or to grow, for example, wheat after wheat, wheat after oats, or oats after barley.

ROTATION AFFORDS OTHER OPPORTUNITIES FOR SOIL IMPROVEMENT

A very important factor in relation to soil fertility and especially in the maintenance of productivity is the soil supply of readily decomposable or active organic matter. An arable soil adequately supplied with active organic matter is usually a productive soil. This points to an important function of crop rotation, namely, aiding in the maintenance of the soil supply of organic matter. Ordinarily, rotation of crops makes it possible for the farmer to accomplish this in different ways: By plowing under good clover or grass sods, by the timely plowing under of weeds in grain-stubble fields, and by the plowing under of second growths of clover or grass, and volunteer growths of rye, wheat, and oats.

In special ways the addition of organic matter to the soil may be accomplished by green manuring. Very often this means the sacrifice of a season's crop; but, in rotation, opportunities are afforded whereby green manuring can be accomplished without the sacrifice of a season's crop. Rye, clover, soy beans, or other legumes may be sown for green manure, in with such crops as corn and potatoes at the last cultivation, or where the season or climate will permit, after the season's crop is harvested. Usually such crops are plowed under in the late fall. Rye, vetch, and clover may be sown after harvest for catch or cover crops, and turned under for green manure in the following spring. When two small-grain crops are to be grown in succession, clover may be seeded in the first crop, say wheat or oats, and turned under in the fall to benefit the wheat crop which usually follows (fig. 13).

When the soil is in a low or medium state of productivity, mammoth clover may prove best for this purpose, being a more rank grower than the other clovers.

INCREASED EFFECTIVENESS OF CULTIVATION, ROTATION, AND USE OF FERTILIZERS

Since permanent soil productivity depends largely on cultivation of the soil, rotation of crops, and the use of fertilizers, it logically follows that, assuming the use of good seed, soil productivity in general may be materially increased by improved methods of tillage, by improved and more systematic rotation of crops, and by the intelligent use of farm manure, commercial fertilizers, and agricultural lime. Whatever efforts a farmer may put forth in maintaining or in increasing soil productivity by the methods suggested in this bulletin, he should at all times be mindful of these two encouraging facts: (1) Crop rotation may prove as effective as the use of farm manure or commercial fertilizers in maintaining or increasing crop yields; (2) when rotation and the use of fertilizers are conjoined their combined effects on crop yields are additive.

Since the ordinary effects of rotation and of the use of fertilizers when practiced together are additive, it logically follows that when a farmer increases the productive efficiency of his rotations and of the use of fertilizers the increased efficiencies of these two practices, when conjoined, will likewise be additive, and will be thus reflected in increased crop yields.

CROP ROTATION THE STARTING POINT IN BUSINESS FARMING

Although in this bulletin the statement is made that crop rotation of some description is practiced by most of the farmers of the country, even though the rotations may consist in merely a change in cropping without any definite system or any degree of regularity, yet in some sections farmers have not yet come to know the economic importance of crop rotation because of the want of diversification in farming. From a general-welfare or economic point of view it is generally conceded that, in most of these sections or localities, diversification, wherever it is possible, is the first important step toward more stabilized agriculture, and this stabilization in turn would lead to more contented farm homes, the only conditions which should prevail generally in order that agriculture may be made a strong national bulwark. Diversification in farming is the mother of crop rotation; and rotation is not only a major factor in the maintenance of soil productivity, but the establishment of systematic cropping systems or of proper rotations is the real beginning of organized or business farming.

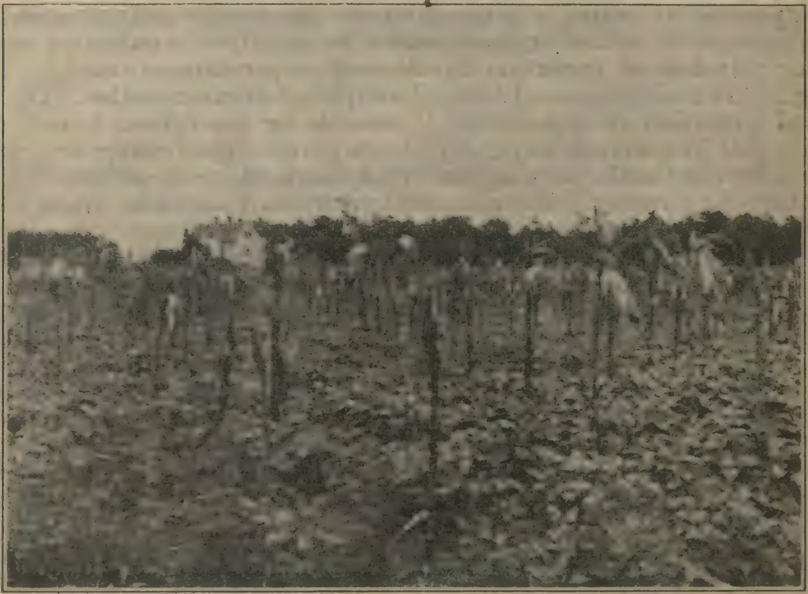

FIG. 13.—Corn and cowpeas after early potatoes (three crops in one growing season), Accomac County, Eastern Shore, Va. The cowpeas are usually plowed under in the fall for green manure. This illustrates how, by means of rotation, a farmer can gather in at least one crop a year and at the same time improve his soils in a way other than by the use of farm manure or commercial fertilizers

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